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UNITED STATES NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

In the Matter of)
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SUBCOMMITTEE ON INSTRUMENTATION)
AND CONTROLS)
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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

In the Matter of:

SUBCOMMITTEE ON INSTRUMENTATION AND CONTROL SYSTEMS

Wednesday,
April 5, 1989

Room P-110
7920 Norfolk Avenue
Bethesda, Maryland

The above-entitled matter came on for hearing, pursuant to notice, at 8:30 a.m.

BEFORE: DR. WILLIAM KERR
Professor of Nuclear Engineering
University of Michigan
Ann Arbor, Michigan

ACRS MEMBERS PRESENT:

MR. CHARLES WYLIE
Retired Chief Engineer
Electrical Division
Duke Power Company
Charlotte, North Carolina

MR. JAMES C. CARROLL
Retired Manager, Nuclear Operations Support Department
Pacific Gas & Electric
San Francisco, California

ACRS COGNIZANT STAFF MEMBER:

M. El-Zeftaway

CONSULTANTS:

P. Davis
L. Oakes
W. Lipinski

NRC STAFF PRESENTERS:

D. Basdekas
K. Kniel

P R O C E E D I N G S

CHAIRMAN KERR: The meeting will come to order. It is a meeting of the Advisory Committee on Reactor Safeguards, specifically the Subcommittee on Instrumentation and Control Systems.

My name is Kerr. I am Subcommittee Chairman. Other ACRS members present are Mr. Carroll, Mr. Wylie. We expect Mr. Lewis and Mr. Michelson.

Our consultants today are Mr. Lipinski, Mr. Davis, and I want to recognize Mr. Les Oakes from Oak Ridge who has recently been signed on as an ACRS consultant and is with us for the first time.

The purpose of the meeting is to review the proposed resolution of Generic Issue 115 entitled, "Enhancement of Reliability of the Westinghouse Solid State Protection System." Mr. El-Zeftawy is the cognizant ACRS staff member for the meeting.

The rules for participation were announced as part of the notice of the meeting published in the Federal Register of Wednesday, March 22nd, of this year.

A transcript of the meeting is being kept and will be available as stated in the Federal Register notice, and I would ask that each speaker identify himself or herself and use a microphone.

Are there any comments or questions from members of the Subcommittee that you want to give any particular attention?

MR. CARROLL: I have none at this time.

MR. WYLIE: No.

MR. LIPINSKI: In looking at options, the one option that was not considered was to leave the existing system there and to add a diverse--

MR. WYLIE: I thought they did.

MR. LIPINSKI: They took one breaker out and put in a contact in its place, but no option--but what if they are both in place and add a third diverse system? And I would like that addressed.

CHAIRMAN KERR: You would like to know why they--

MR. LIPINSKI: Didn't consider it.

CHAIRMAN KERR: In your presentation; any other comments?

I would like to comment, and in light of having reviewed a resolution of another issue fairly recently, that I have found an evaluation described in, published in NUREG 5197 a much more cogent and understandable analysis. I thought the preparers did--at least to me it was understandable and it seems logical, and it did not go to common mode failures, although the treatment of common mode failures still strikes me as smacking of witchcraft to some extent. Nevertheless, they used the witchcraft in an acceptable, in an accepted manner.

MR. MINNERS: You forgot uncertainty.

CHAIRMAN KERR: Well, I did--in reading it, I was a bit curious and perhaps I missed this. If I did, I like to think it may have it identified. There seems to be no discussion of possible vulnerability of solid state system to electric spikes, the kind that might be generated by lightning, or perhaps it was there, and I missed it.

Then it also, I did not see any comments on possible common mode failures that might be due, for example, to overheating which would be caused by failure of the air conditioning system, and at least some solid state systems are vulnerable to this sort of thing, and I really wasn't sure whether I missed it or whether it is just common knowledge that it isn't vulnerable or something, so I would be interested in a comment.

Then in not the analysis itself, but in the letter that Mr. Beckjord wrote, there were some recommendations that resulted from this study for existing reactors, some things that might be done, not necessarily to be required by the staff I gathered, but some suggestions, and I think this is, this is a good idea because it would be unfortunate for all this effort to occur without some recommendations, and of course, one recommendation that is logical is to leave things alone, but at least the studies that were suggested may be make sense.

However, I would also recommend that this staff not confine itself--in fact, I guess the staff didn't confine itself to existing reactors. It did I think say that this could be applied both to existing and to future reactors, and if that was the case, I would suggest also that some consideration be given to recommendation that future designs be changed slightly so that ATWS is not a problem.

I'm convinced that you can certainly make the consequences of an ATWS, of an ATWS much less severe than it is in some existing systems by design changes that at least people who know more about design than I do seem to think might not be so traumatic, and it does not appear to me that in the new reactors that are being considered, I guess the evolutionary ones, these changes are being considered seriously.

Those are the comments I had. And let's see. Mr. Kniel it says is going to open things up. Is that correct, Mr. Kniel?

MR. KNIEL: My name is Carl Kniel. I am Chief of the Reactor Plant Safety.

CHAIRMAN KERR: Don't be mike shy. Any of you who would find it more convenient to sit here at the table to use the Mike, please feel free to do so.

MR. KNIEL: My name is Carl Kniel. I am Chief of the Reactor Plant Service Issues Branch, the Division of Safety Issue Resolution, and we are here this morning at the invitation of the Committee to give you a presentation on the, our resolution of Generic Issue 115, and this is, we are doing this in, as a follow-up to the agreement between our management and the Committee as to that you would at your option that you want to review issues for which we don't have a new requirement, and as you are aware, this particular issue doesn't have a requirement, and we sent it down to you at your option to have a meeting, and you have elected to have a meeting, and that's why we are here today, and Demetrius Basdekas is our task manager, and he will give the presentation on this issue.

CHAIRMAN KERR: You didn't say we are delighted to be here.

MR. KNIEL: No, I didn't.

MR. CARROLL: Are you?

CHAIRMAN KERR: Don't answer.

MR. MINNERS: Take the Fifth!

MR. BASDEKAS: My name is Demetrius Basdekas, and I'm with the Reactor Plant System Branch, Division of Safety Resolution, and I'm the task manager for the resolution of Generic Issue 115, which has been to develop the Westinghouse protection system.

During my presentation I will try to give you some of the background that led to this establishment of this issue. I will give you the objectives and scope that was established for this resolution, and I perfectly understand the comments that were made earlier to the effect that perhaps this scope might or might not have included some additional options or some additional evaluation that otherwise might have been appropriate.

As you may recall from your previous experience, and as well as from reading the package that was sent you recently, this generic issue was established as a result of the two ATWS events that have taken place at the Salem plant in 1983. Those events initiated a number of actions, notably including the issuance of a Generic Letter 83-28, and as a sequel to that generic letter, another evaluation were performed by the staff as well as the industry, and the scope of this generic issue was established at that time as one that the staff had particular concerns regarding the reliability of the undervoltage driver card in the Westinghouse plants which had exhibited some problematic behavior in terms of failures that would have prevented possibly the action of the reactor when needed, and also the problems associated with undervoltage tip device, the undervoltage coil in the reactor assembly itself, so in other words, work will be addressed and have been, and/or are being addressed under Generic Letter 83-28, and the implementation that the staff has made for the scope of this generic issue is basically two options which were basically centered around fixes of problems associated with the undervoltage driver card which showed problems either by accepting the recommendations of Westinghouse which submitted, who sent a bulletin to all of the utilities outlining the problem and proposing solutions both in the near as well as in the long term as well as an additional staff recommendation of providing a redundant driver for the undervoltage coil that will be made of drivers, namely, relays placed vis-a-vis the solid state component, components that were used by Westinghouse, but as the generic issue progressed through its process of definition and subsequently more importantly, through its process of the resolution phases, it evolved somewhat and it evolved in the sense that the staff felt there were some additional options that ought to be considered, and the two increased to six, and then we had some more comment, but I'll discuss these options just as we go here.

(Slide)

MR. BASDEKAS: As I mentioned, there were ultimately six options that were evaluated that came out initially, but as well as in the process of our evaluation of the initial two options as we were going through the evaluation of this issue and as we, the staff and others were going through their evaluation of the licensee responses or compliance with the requirements of Generic Letter 83-28, then some additional options were suggested to us which we undertook also to evaluate in a large initial scope of this issue.

The first option I already touched on briefly, was a, simply the replacement of the existing undervoltage driver cards in the logic cabinets supplied by Westinghouse to avoid the problem of shortened output of that card and damaging the transistor, the output transistor of that card that would have resulted in undetected failure leading perhaps to failure of the tip if it was, if both cards were involved, both things, so Westinghouse had recommended a new design of a card that simply incorporated the fusable, the output of that cards so that the particular failure mode would be eliminated. It would still open up and not be able to, you know, to stop the reactor, but nonetheless, it would have eliminated, does eliminate the possibility of having undetected failure that results in a failure of the breaker to trip.

Our survey showed that some of the licensees have choseen to modify the operating procedures and introduce test procedures that will avoid shorting of the output, but some others, and I think they are the minority, chose to purchase these new modified cards from Westinghouse and install them in their system, so it is, it has been a mix, and--

MR. CARROLL: One of the things that was not clear to me in going through this material was what was the nature of or what really caused these various failures?

MR. BASDEKAS: It was during the periodic testing process that the technician would short out the output and damage the transistor.

CHAIRMAN KERR: In one word, what--

MR. BASDEKAS: Pardon me?

CHAIRMAN KERR: I said in one word, what caused it?

MR. BASDEKAS: Operator, maintenance testing.

MR. CARROLL: The statement is made somewhere that Option 1 would cure four of the five failure situations. What was unique about the fifth?

MR. BASDEKAS: It would not cure all failures. It will cure the possibility of having the, this particular card, the transistor in particular, damaged in such a way that it will not trip when it was supposed to and by fusable link--

MR. CARROLL: But of the five actual failures, I thought I read that Option 1 would have dealt with four of the five?

MR. BASDEKAS: Yes.

MR. CARROLL: What was unique about the fifth one? I didn't find--

MR. BASDEKAS: Okay. The fifth one, Don, wou d you comment on this one, please, what we have done? Okay. I will tell this later, but in any event, give a quick response.

MR. CARROLL: I can wait if you are going to cover it later.

MR. BASDEKAS: Go ahead.

MR. RENY: I am Dan Reny from EG and G Idaho. The fifth failure was a random failure of component in the undervoltage driver card unrelated to the other four failures which caused the transistor switch problem, so the fix would not affect that fifth failure.

MR. CARROLL: On page 25 of the NUREG, which of those failures is that?

MR. BASDEKAS: Referring to NUREG or NUREG/CR?

MR. CARROLL: NUREG/CR.

MR. BASDEKAS: Okay.

DR. KERR: Do you have a copy readily available, Mr. Reny?

MR. RENY: I do.

(There was a brief pause in the proceedings.)

MR. RENY: The first one, the diode failure.

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MR. CARROLL: Okay. That's what I guessed. All right. Thank you.

MR. BASDEKAS: We do have a--okay--details under the specific options, and they are proposed, what the staff outlined and we have examined here--we can cover later, and I do have some other--the last six vugraphs are back-up vugraphs, schematics of each one of the options, so let me go quickly over the other options we have examined.

Now Option No. 2 involved, I referred to earlier as a diverse undervoltage driver, relays to be installed in parallel with the existing solid state undervoltage driver cards.

Option No. 3 involves the diverse RTB actuation mechanism that involved the incorporation of another current type of circuitry that will burn up a fusable link in the same line as the RTBs.

Option No. 4 involved the deployment of an extensive diverse redundant trip logic system constructed of relays that will be the redundant and diverse counterpart of the existing solid state universal trip logic system that comes closer basically to what now Westinghouse plants would be required to do.

Option No. 5 involved the replacement of the undervoltage driver, the undervoltage coil, the undervoltage trip device which turned out to be the most unreliable in the particular part of the system, with a device of similar design as the shunt trip device.

And Option No. 6 involved the replacement of one reactor trip breaker with a contactor, and that presently you may recall we do have a configuration of one of the two--we have two reactor trip breakers in series and two bypass breakers in series connected in parallel, so this is, we have replaced one reactor trip breaker and one bypass breaker with a contactor being a simpler device, device existing for reactor trip breakers, the best approach we took.

MR. WYLIE: Would this be a time to talk about the question about why other options were not considered?

MR. BASDEKAS: I'll be glad to answer you.

MR. WYLIE: Do you want to restate the question?

MR. LIPINSKI: My question is why didn't you add a third diverse trip system? Let me point out these two mechanical breakers are the weak link in this entire system. Just scanning over your data, in fact your data factor under there is something like five times ten to the minus 3 probability of failure to demand on both of them.

MR. BASDEKAS: No. I think the numbers, we have got--

MR. LIPINSKI: You did your analysis but giving two breakers in series, and if I take their independent product and use it the way the new data compares, you should end up with five times ten to the minus 3. When you get to the analysis, we will take a closer look.

MR. BASDEKAS: Let's do that. I think we will be delighted to do that. It's an issue that has been debated extensively. It's a good legitimate question and we will address it. Can we take a few minutes as we go through it and and come to a point where we can do that?

MR. LIPINSKI: Sure, but the point is using my contention that the two breakers are the weak link in the system, you would have to go in with a third system that would be diverse and not subject to the common cause failure.

MR. BASDEKAS: I understand your point.

MR. LIPINSKI: Let's talk about common cause failures. You are looking at a single plant. I am going to postulate that Westinghouse came up with a new super lubricant and then sent a letter out to all the operators saying here is this lubricant, install it in your breakers, but this lubricant has a peculiar property. It works nice for one year, after one year, turns to a property like epoxy, so now I not only have a common mode on the single plant, I have a common mode on a population of plants due to this common cause.

That type of analysis is not factored in, but given a diverse system, I think you have a lot more to offer in terms of going to a diverse trip.

MR. BASDEKAS: Well, let me defer responding in detail to your question, and I think already in this case Don will be also helping with the presentation because he will give you, when we come to it, a detailed step by step description of how we have done this analysis, the assumptions we made, if any, and the data we used, how we model the system, how we derive better factors for common cause failures, and will give you the reasons why our data turned

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out to be based on what you cited for the two breakers combined, which is basically the trip function of, the good part of trip function, of the trip function of the reactor itself, the unreliability of that. Then we will show you that our numbers are different markedly from yours by--

MR. LIPINSKI: Let me ask you this question. Your report does not deal with sizes. What is the interrupting current and voltage that goes through a breaker?

MR. BASDEKAS: Well, it is 480 volts. I don't remember the amperage, but it is certainly--Don, do you happen to remember?

MR. RENY: I believe it is 600 amps.

MR. BASDEKAS: So we have examined the existing, you know, breakers, and we have examined operational experience. We have examined the potential failure modes that may be involved. We have used an approach for figuring out the common mode factors the other factors.

MR. LIPINSKI: We will talk about common mode later?

MR. BASDEKAS: Sure.

MR. LIPINSKI: In terms of waiving--but diverse is not coming into the picture other than in your one case.

MR. BASDEKAS: We did provide in one case, you will notice we provided a fusable link for both trains.

MR. LIPINSKI: That doesn't get rid of my mechanical breaker common mode.

MR. BASDEKAS: But it is a diverse way of interrupting power.

MR. LIPINSKI: It does not guarantee the two mechanical devices will function if I have done something wrong to them.

CHAIRMAN KERR: Why don't you, as you said, look at this in detail? There is a more logical matter.

MR. BASDEKAS: I will come to it and I will keep it in mind to revisit the question.

The best approach we took here was to--

MR. OAKES: Demetrius, I wanted to ask a question. Perhaps it isn't the correct time to ask it, either, but maybe we will take the issue up later.

Are you going to discuss these options in more detail, or is that the last time you are going to talk about the options?

For example, Option 1, one's sensitibility is offended by the fact that we have solved a, what appears to be an incompetence problem in maintenance by adding a non-testable device, a fuse.

MR. BASDEKAS: No. It is not--well, they, they have provisions for considering the fuse and make sure that it is--

MR. OAKES: What I was going to ask is--perhaps this isn't germane to our discussion, but have other options for limiting the current been looked at, something that is testable by current limiters, and does one know that the fuse will always blow before the resistor is damaged in this case? Are there data to support it?

MR. BASDEKAS: It is a quality assurance question.

MR. OAKES: Have tests actually been made to show that it will or not in most cases blow before it damages the resistor?

MR. BASDEKAS: I'm not aware of any test performed by Westinghouse or anybody else, but the description of the quality assurance is programs, they do address the integrity of the new design, notably the fuse.

CHAIRMAN KERR: Mr. Reny, you were about to make a comment?

MR. RENY: Yes. The fuse was added to prevent the use of the undervoltage driver after a short circuit has been applied to it such that the undervoltage driver would have to be removed and tested prior to its use again, so the fuse prevents the use of the cards in case the transistors have been damaged before the fuse blew.

MR. LIPINSKI: You are saying short, but you can have various degrees of shorting which are not necessarily zero ohms that draw current.

The question is can you draw the current through that fuse damage, the output transistor, and not blow the fuse?

MR. BASDEKAS: The size of fuse was determined on the basis for such as the--

MR. LIPINSKI: Zero ohms, that is an assumption on your part--they are very low in peak shorts that draw high currents.

MR. BASDEKAS: That's a good point, but I think it has been provided as part of the design. Faust Rosa?

CHAIRMAN KERR: Faust, will you come to a mike, please, sir?

MR. ROSA: I am Faust Rosa, Chief of the Electrical Systems Branch in NRR.

I recall the presentation that Westinghouse made on the subject of these driver cards some years ago, and as I recall, the fuse is rated at about five milliamperes, and the transistor can withstand up to around 20 milliamperes, so there is, there is very little change that a short circuit will not blow the fuse before it damages the transistor.

MR. WYLIE: Let me ask a question in that regard. You know, they have a habit of opening when you don't want them to open.

Do you know whether Westinghouse or anybody looked at the increased probability of SCRAM rates due to the addition of these fuses to opening when you don't want them to open?

MR. ROSA: I'm not aware of any Westinghouse study on that.

MR. BASDEKAS: However, they did make a provision, Charlie, that they do X-ray them in case there is some defect.

MR. WYLIE: You know, fuses as they age, at least my experience has been that strange things happen. They open when you don't want them to open. They all are good when they are new, but generally these are silver sand fuses or some other type of fuse, and after some years, why they start opening, and I wondered whether anybody looked at that as to what the risk associated with increased SCRAM rates are by adding fuses.

MR. KNIEL: I think about--

CHAIRMAN KERR: Microphone, please, sir. We record these priceless words.

MR. KNIEL: According to an INPO document, 25 percent of the SCRAMs come from various malfunctons in the reactor protection system at this stage, so--I think it is 22 percent to be exact, so I don't think that this hypothetical mechanism you are talking about is going to have very significant impact on something that is already pretty, pretty dominant.

MR. WYLIE: You mean by increasing the scam rate?

MR. KNIEL: Right. And the SCRAM rate deficiencies, I mean the deficiencies from the SCRAM rate come from other components in the reactor protection system, principally the instrumentation and the, and the lines that bring in the instrumentation and that kind of stuff; doesn't come from the reactor protection system, the SCRAM breakers.

CHAIRMAN KERR: Let me say I wasn't sure I understood what you said. Twenty-five?

MR. KNIEL: Twenty-two percent is the number.

CHAIRMAN KERR: Twenty-two percent of the false SCRAMs, what other term we were using, come from malfunctions of the trip breaker?

MR. KNIEL: No--come from malfunction of the reactor protection system.

CHAIRMAN KERR: Oh, okay.

MR. KNIEL: Only a very small fraction of those come from the breaker malfunctions. This is the existing data that we have today.

CHAIRMAN KERR: I don't know what 25 percent means.

MR. KNIEL: I think right now what is it, like four SCRAMs per reactor year? Per plant; roughly in the ballpark, so--

CHAIRMAN KERR: If you had an additional SCRAM, it would incrase things by 20 percent? Twenty-five percent I guess?

MR. KNIEL: Yes.

MR. LIPINSKI: Per year?

CHAIRMAN KERR: Yes.

MR. KNIEL: What I am trying to point out is that this small slight increase in possibility of the fuse failing and SCRAMing the plant, what appears to me a microscopic number compared to what we have in the existing--

CHAIRMAN KERR: The response to Mr. Wylie's question is nobody has looked at it?

MR. KNIEL: That is correct.

CHAIRMAN KERR: Which is what he asked, if anybody had looked at it, and the answer is nobody is?

MR. KNIEL: Well, I am trying--

CHAIRMAN KERR: Perhaps for good reason.

MR. KNIEL: I am trying to give you the facts as I understand today as reported in the INPO report, and the implication is that the mechanism that suggested would have a very minor--

CHAIRMAN KERR: He is not the sort of person that goes around making implications. He just asked a question.

MR. KNIEL: Okay. I am trying to give the--

MR. BASDEKAS: Let me reiterate what I said earlier. It is a concern, good one. It is a valid one shared by Westinghouse. They provided, they have a provision as part of their quality assurance program to X-ray these fuses before installation.

Now whether or not this calls for priority X-ray, I am not in a position to say, but that we will find out. I

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will let you know, Charlie, so that we close the loop on this question, but as I said, it is a concern that is shared by Westinghouse and the staff and to address it at least in a practical, meaningful way, will be to have the X-ray at least before installaticn. I'm not sure if that entails also X-raying priority thereafter.

Going back to the--

MR. CARROLL: I have one thing that was troubling me. I guess I heard that Westinghouse rates the fuse, what was it, 5 milliamps? And the transistor is quote, good for 20 milliamps, and that really doesn't tell the whole story.

The fuse blows, it doesn't heat, which is there is some relationship between current and resistance and time, and the transistor is damaged because of heat which is some other relationship involving current and resistance and heat and time.

I'm not sure a 5 amp, quote, 5 amp fuse protects a quote, 20 amp rated transistor on the face of it.

MR. BASDEKAS: Well, I do not have that direct knowledge, but I think based on my understanding of what the process of sizing design in this particular modified card, we went to the sizing of the fuse.

I cannot--Faust--

MR. CARROLL: Did Westinghouse run tests that would make me feel better if they did?

MR. BASDEKAS: I cannot answer the question.

MR. ROSA: Yes, Westinghouse did run tests, and the addition of this, this fuse in the output driver card is their recommendation, which they have transmitted to all of their licensees.

MR. LIPINSKI: Let me pursue that question because I would venture probably the test that Westinghouse ran was a steady state test, but you put a transistor test on, you have a momentary short and release it; did they look at it as a function of time, zero out in terms of mode seconds application of the short?

MR. ROSA: I have no idea of the details of the test.

MR. LIPINSKI: Then it is a race between the heating of the fuse and the heating of the transistor as to who goes first.

MR. BASDEKAS: I think the fuse will go first.

MR. LIPINSKI: But the point is if I only have a momentary and then heat the fuse long enough to open it, but I could blow the transistor which is faster responding temperature-wise--

MR. BASDEKAS: Your point is well taken, but we do have fuse and fuse, we have quick response fuse and slow burning fuses.

MR. LIPINSKI: Right now we are discussing the critical point in the decision.

MR. WYLIE: What kind--

MR. ROSA: Demetrius, about seven or eight Westinghouse plants have installed these driver cards. They have been installed for some five years.

MR. BASDEKAS: It varies. Not necessarily; some perhaps as long as five, some perhaps as long as one or more.

MR. ROSA: We haven't had any reports of a failure of one of those fuse scausing a spurious SCRAM.

MR. CARROLL: But the other variation of that is to disable the driver cards and don't know it. In other words, making this mod seems to me to give people a false sense of security.

MR. BASDEKAS: If the fuse, if the fuse burns or if the fuse does not burn, it does not burn, you are no worse than what you have with the fuse.

MR. ROSA: The fuses in this series is with the, with the trip coil, the undervoltage trip coil, so if the fuse blows, you get a SCRAM, period.

MR. CARROLL: But the transistor is damaged.

MR. ROSA: Then you must rely on your periodic testing which occurs every two months, every two months now.

MR. BASDEKAS: Highly unlikely occurrence, Mr. Carroll.

MR. LIPINSKI: Let's get back to the testing mode.

Are both--

MR. BASDEKAS: Of what?

MR. LIPINSKI: Undervoltage drivers; are they both tested at the same time, or tested on alternate months?

MR. BASDEKAS: Alternate months.

MR. LIPINSKI: So they can't be subject to the same failure at the same time?

MR. BASDEKAS: That is correct. The basic approach we took in resolving of this issue, as you know, it is basically that one deploys, of course, the cost/benefit the methodology, and to accomplish that we perform a reliability analysis of the reactor trip system. We started with the base case and we have done the same thing for the options as modified based on the proposed modifications.

We did core damage frequencies for each one of them. We proceeded to the consequences based on a site, typical Midwestern site characteristics. We did perform a cost analysis for each option, and we did perform a scientific analysis to show us the level of confidence we can attach to the results we are getting and to see which parts of the system are the most contributing to risk in this particular system.

And finally, we, and I see a mistake here which on the slide we have a discussion with the decision rationale and the recommendation we developed as a result of this analysis.

(Slide)

MR. BASDEKAS: I will try to discuss next the steps we went through to have the, this process accomplished, and the first thing we have done was to evaluate the, the base case six options.

The base case includes the automatic shunt trip function which was added after the 1983 events at Salem. That particular addition alone contributes significantly to the improvement of the trip reliability.

We have made some assumptions here that we find them reasonable, and they are namely, we assume that all electrical power sources were available to allow the reactor protection system to function properly, and we have also assumed that once the trip is initiated, it will go to completion as far as movement of the control rods. In other words, our scope of work did not include the mechanical part of the actual rods per se, move it into the core.

The next vugraph shows the functional diagram and one that we used--the reactor protection system, and one that we used to model it for purposes of analyzing its reliability.

(Slide)

MR. DAVIS: Excuse me. I have a question on your previous slide.

MR. BASDEKAS: Previous slide, yes, sir.

MR. DAVIS: Did you assume that if SCRAM failed, you would always get core damage?

MR. BASDEKAS: No.

MR. DAVIS: Because I believe for Westinghouse plants, they can ride through it and not guarantee it is unfavorable.

MR. BASDEKAS: That is correct. We took that into account, and we can cover it as we go down the line in the consequences and the calculations.

MR. DAVIS: You may want to revise the last paragraph, Roman 12, of your NUREG 1341 because it says there that SCRAM must take place within one minute to avoid core damage.

MR. BASDEKAS: I see--in most cases.

MR. DAVIS: I'm not sure it is in most cases.

MR. BASDEKAS: At least in selected cases.

MR. MINNERS: Don't rewrite it now.

MR. BASDEKAS: It is intended to show it is important as far as the operator action goes. It is part of the operator take some action within one minute.

DR. KERR: No matter what it is intended to show, if it is incorrect, I expect you will want to look at it again.

MR. BASDEKAS: We will certainly look at it.

MR. DAVIS: Westinghouse has made a big case for installing the AMSAK system that will allow them to ride through the SCRAM failure.

MR. BASDEKAS: That is exactly right. We will discuss that in the Executive Summary as well as in--

MR. MINNERS: What was the page again?

MR. DAVIS: Roman 12, the last paragraph; thank you. You have answered the question.

MR. BASDEKAS: Sure. Thank you.

(Slide)

MR. BASDEKAS: Okay. This document shows the best portions of the reactor protection system are on the basis of--which our contractor developed the reliability model that was implemented in the IRIS computer code. That stands for Integrated Reactor Risk Analysis System, and this has been very useful in being able to analyze the various options as well as the sensitivity of the system to various parameters that are involved here.

Basically as you see here, as you have seen before, is the channels, and the number of them varies from design to design. Some, they have three. Some may have four, or even two in some instances.

Then you have the input relays and universal logic, part of which is the undervoltage driver cards on both trains, and finally, the two reactor trip breakers.

As you notice there, the operator enters and can override or compensate for a failure in the system starting with the input relays up to and including the undervoltage driver cards. This was part of the considerations we had to, we did make and carry a number of these calculations starting with the particular ability core damage frequency consequences and cost benefits with or without operator action. We felt strongly that operator error here can have some significant impact, and we have carried this throughout.

The next--

MR. CARROLL: With regard to the operator action, I'm sure it doesn't apply or doesn't have a major effect, I guess I would point out that in projects with a high seismic design, the operator ain't there. He is on the floor.

MR. BASDEKAS: For most cases--

MR. CARROLL: Is not available to intervene and initiate a SCRAM.

MR. BASDEKAS: Sure. That is correct. That's, for those cases, we have calculation performed without operator action, and the attendant numbers, string of numbers that we have calculated, so the sensitivity of operator error of omission or just inability to perform a safety action, it's reflected in our calculations.

(Slide)

MR. BASDEKAS: Moving on here, I think the next slide will show an apportionment of the unreliabilities of the reactor trip system. As you see here, common mode failures dominate the risk contributions. The reactor trip break is common cause failure rate ten to the minus 5 and represents 40 percent of the total, and so does the analog channel common mode failure distribution, and only 20 percent is represented by others, principally independent failures as well as some common cause failures that are rather weakly linked in the contributions.

The reactor trip and unreliability results are, for the base case, are calculated in the performance slide. I am just going through the slides quickly just for the sake of completion. You have seen them tabulated in the reports before, and I don't want necessarily to be repetitious of what is in the report because you have seen them or you would have seen them I assume.

And the contributions, here we are talking, well, the unreliabilities of the base case before everything, any of the options were incorporated there and analyzed, without operator action were five times ten to the minus 5, and with operator action, 2.5 times ten to the minus 5, so the operator action there accounts for a factor of two in the total unreliability of the function.

(Slide)

MR. BASDEKAS: The next slide shows the same numbers for each of the options, and I would like to draw your attention to the bottom line there, the total, and most specifically the delta from the base case, the change from the base case which these numbers here are, the minus sign denotes a reduction in the unreliability, and you will see here that all options have a minus sign in front of them except for Option No. 5, which have an increase in risk.

Well, that's an eye opener for us because the situation for that option is that if we replace the undervoltage trip device which had proven to be the most troublesome in the reactor trip breaker failure rate, the studies, if we replace that with a shunt trip device which turned out to be something like ten times more reliable than the undervoltage device, then we felt perhaps we are moving the reactor and therefore we increase the reliability of the system.

Well, it turns out by removing the undervoltage device and replacing it with a shunt trip, we were removing an important diversity from the system, so the common cause--

CHAIRMAN KERR: Diversity which you quantified by guess?

MR. BASDEKAS: Pardon?

CHAIRMAN KERR: And a diversity which the contribution you quantified by a guess?

MR. BASDEKAS: No. Was not quantified by guess. Was quantified by rational experience.

CHAIRMAN KERR: Operational experience in terms of?

MR. BASDEKAS: Yes, operational experience, the same event and the benefit factor.

CHAIRMAN KERR: The same event, you were saved by having a shunt trip.

MR. BASDEKAS: Well, let me put it in perspective. There was no shunt trip in the same event because the shunt trips were still late, so it was at undervoltage devices or except for manual.

CHAIRMAN KERR: I thought you were going to convince me of the shunt trip. You are convincing me now that the undervoltage trip is unreliable, and I don't have to be convinced of that. I am already convinced of that.

MR. BASDEKAS: We removed the undervoltage and replaced it with the shunt which was more reliable.

CHAIRMAN KERR: That makes the whole thing less reliable, and I am saying that conclusion is reached by, based on the contribution that you give to diversity, and that is unquantifiable.

MR. BASDEKAS: Well, we used persistant sets of data as far as, as far as the benefit factors of the--

CHAIRMAN KERR: Consistency can be both wrong and right. You know, you could be consistently wrong.

MR. BASDEKAS: Right, and we can be consistently right, which we hope that was the case, and since you brought up the subject here, it may be a good time to ask Dr. Reny very shortly to give his brief presentation of our, exactly what data were used for components. In other words, the undervoltage, the shunt trip, and the overall breaker reliability, you know, as well, one by one based on operational experience were extracted from whatever source you could get, including the NPRDS data, so let me finish this here and point out the fact that okay, all options showed a favorable result here except one, and I do appreciate your statement that the benefit factor is something that had some uncertainty associated with it, but to offset it in more concrete and specific terms, I would like to ask at this time Don Reny to give you a brief discussion of what they have done for us in this area, and hopefully we will answer your questions in a way that I believe will be an intelligent and defensible conclusion.

Go ahead.

MR. LIPINSKI: The data factors were confirmed statistically?

MR. BASDEKAS: Why don't we let Don--

MR. MINNERS: Let's finish up your presentation, okay?

MR. BASDEKAS: We will make the presentation. Fine.

MR. MINNERS: Why don't you finish up and then we can do this sidebar stuff at the end?

MR. BASDEKAS: Okay. The next step in the process applied earlier was to perform core damage frequency results, and these analyses included directions of the NTC and the overall thermal hydraulic behavior of Westinghouse plants, and the results that we got here are, do show, the minus sign here denotes an increase in CDF, and you see Option 5 reflects the same type of behavior that we showed earlier in the reliability calculations.

(Slide)

MR. BASDEKAS: The consequences--okay. The cost/benefit evaluation methodology involves specific analysis. This is basically summarizing these specific steps.

The ATWS event consequences, the core damage analysis, the generic consequences analysis which I referred to earlier as a set of characteristics for a typical Mid-western site, the proposed analysis for each proposed option, and the proposed options cost/benefit results--the approach here was taken in an analytical sense, it was to vary the reactor trip reliability and cost for each option and hold the rest of the parameters constant, and finally evaluate the option changes from the base case.

MR. DAVIS: I have a question on your consequence analysis. I realize this is a difficult one, but I noticed that your consequences varied quite a bit and you had to select a number, I think it was 2.4 ten to the minus 6 or ten to the plus 6 person-rem per event or something like that.

MR. BASDEKAS: All right. Yes.

MR. DAVIS: And that was based on an analysis done with the CRAC code. Of course, now the last couple of years that code has been replaced by the MACKS code which actually produced higher consequence because of the revised lung dose models.

MR. BASDEKAS: Right.

MR. DAVIS: I am wondering if you looked at, for example, NUREG 1150 results to see if there is a big difference between what you use and what is now being calculated for that accident?

MR. BASDEKAS: Your observations with respect to the CRAC code are correct, and we had our Idaho people follow us as close as practically, as practical, what analysis were done, as part of the 1150 work were done. Would you like to comment some specifically, if it is a quick response? Otherwise we will cover it later.

MR. RENY: Yes. There is a wide spread. However, the two low points of the four consequence data points I used here were taken from NUREG 1150 for the Surry and Sequoyah plants, consequence analysis for ATWS events that led to core damage, so the NUREG 1150 studies actually showed lower consequence results for ATWS events that led to core damage.

MR. DAVIS: I think those were the previous system results and not the most recent. Maybe they haven't changed that much, but the reference you gave for those two cases was

11 a report by Benjamin I believe, which is 1986, so it must have been the original NUREG 1150 calculations. I don't want to belabor it now, but I think the concern is that you can get substantial variation in consequences, and that has a linear input on your cost/benefit analysis.

MR. MINNERS: Is that something new, Pete? The last time I talked to the people who I though knew something about variance he said there wasn't that big a difference between the two.

MR. BASDEKAS: In the ATWS at least category, that was our impression. Now we will check it out.

MR. DAVIS: You could be right. I have not myself seen the NUREG 1150 results for ATWS, for Westinghouse plants.

MR. BASDEKAS: We made the point since a particularly--because of the group that was doing the work for us were sitting next door to the ones working 1150 and the successful thing to do at least keep an eye and talk to one another as to what was going on, and I think what Dr. Reny says basically is that--and what Warren Minners also said, they were not too far off in the ATWS.

MR. DAVIS: My impression is the number you used is possibly conservative, which would--

MR. BASDEKAS: As a matter of fact, it is. There are--

MR. DAVIS: Tend to support your overall conclusion.

MR. BASDEKAS: That is exactly right, because we knew over the 25 rem, you know, limitation, placed under the CRAC calculations, we are mindful of that, but we will make allowances to compensate so that we have, you know, a more conservative outcome, but your point is well taken.

Here we show briefly the cost results. I'm not sure if we need to go through number by number under the option-by-option basis.

(Slide)

MR. BASDEKAS: We did get some estimates that we call the best, but there are some things and some, some people can argue that well, it is too high, some people, it is too low. We took the respondents' view into account, and our own independent judgment, and came up with a low, best, and high, and it was one distribution, a triangular, linear type distribution that was used later on in a separate analysis.

The next, I think the next few tables are just reductions of what was in the main two documents that we have seen, but I think it will be worthwhile to go selectively over some of them, and what we see on this particular table is the cost/benefit calculations we received both in terms of person-rem reduction without operator action, and with operator action, so as I indicated earlier, we made the point to carry this throughout and observe the sensitivity of operator action, you know, as we went down the line basis rather than just do it once and forget about it.

MR. DAVIS: I have a question on that table. The numbers don't seem to agree with the table on page 12 of your NUREG 1341 report in the cost/benefit per person-rem column.

MR. BASDEKAS: With or without operator? Because there perhaps we give only--I don't remember. Okay.

MR. DAVIS: Neither one of them agree, although the with operator SCRAM is much closer. I don't know if I am comparing it right or these tables are directly comparable or not, but you might want to check on that.

MR. BASDEKAS: Okay. Let me make a note and check on this because we have different, we presented the results in different ways, and what may be the page number what--you said page what?

MR. DAVIS: Roman Numeral 12.

MR. BASDEKAS: Okay.

MR. MINNERS: Table 10 on page 21 is the same number.

MR. BASDEKAS: Later on--okay.

MR. MINNERS: We just screwed it up in the Executive Summary.

MR. BASDEKAS: Well, I'm not prepared to say. Let's not resolve this right here and now. If it is a mix-up of tables, we can fix this up, but they came from the same source, and as Warren points out, on page 21 and this slide, they are consistent. We will check it out.

MR. MINNERS: Must be a different table. On page 14 they have got the same numbers.

MR. BASDEKAS: It probably is, but Warren, let me take your advice seriously and say let's go on with the presentation and we will resolve this later.

MR. CARROLL: Now on the thousand dollars per man-rem basis, doesn't that suggest Option 3 at least--

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MR. BASDEKAS: It shows that it would be cost beneficial, but there is a good reason why we decided that it was not. This was based on point estimates that we received from a single source, the source being the proprietary of the particular option, when performing a sensitivity analysis, receiving independent cost estimates in writing, and we made our own judgment.

It turned out both in terms of say new point estimates, more particularly the uncertainty mean numbers we received or we got from the low and high numbers of the range, of course, for a particular option showed it not to be cost effective ultimately, and I believe that we have a discussion, decision rationale for that particular option and point out why we chose a different number than the one that appears in this particular table.

MR. CARROLL: I read all that. Then I see you are presenting this table again.

MR. BASDEKAS: Okay. As I said, it is a progression of things we have done, and here this table historically speaking did not include an uncertainty analysis, not yet.

MR. CARROLL: All right.

(Slide)

MR. BASDEKAS: Now we will come to the uncertainty analysis. I think the uncertainty here is two basic components that draws the set from--that's the model, the model that we started earlier, used for reliability calculations for the system, and the other is the ATWS events sequence model that we used as consequence analysis, that we do have some uncertainties.

Then the other group of uncertainties come from the data that we used such as operational experience. The failure rates were calculated and so forth, so there is uncertainty. Uncertainty was calculated for each option based on the base case risk uncertainty and on the option risk uncertainty.

The cost uncertainty steps I said, described earlier from the cost data we have received from various sources, some better than others, of course, and these were evaluated quantitatively, and the cost/benefit uncertainty is the cost uncertainty divided by the risk uncertainty.

Now the data uncertainty, and I don't want to--but it is important to describe, that is the basic process we went through here.

(Slide)

MR. BASDEKAS: In calculating the data uncertainty; there were three basic steps, and each of the steps involved a distribution of a given parameter, namely, step A included--and I have an attachment here for the lack of anything better or anything, Monte Carlo calculations to the two mode distributions to come up with a third distribution, and the UNC standards for uncertainty in brackets throughout this particular slide are intended for whatever operations were necessary in the analysis, statistical analysis, the data--I took them up with it basically, so the uncertainty of the core damage frequency was calculated by performing an uncorrelated Monte Carlo random sampling of the distribution for the reactor trip unreliability, and for the initiating event sequences.

There was a log normal distribution assumed for the reactor trip unreliability and almost normal distribution for the initiating event sequences resulting in a distribution and attendant uncertainty on the right-hand side of the equation of the core damage frequency.

The next step involved a single operation here involving the core damage frequency distribution which we derive from A, the consequences distribution times the reactor years. We figure it out in terms of for all plants, and that was the uncertainty and the risk, and finally, step number C included a similar operation, but this one here was a correlated Monte Carlo random sampling because both the base case and the option case risk, associated risks were not independent. They were correlated, so that was the basic analytical process used here to calculate uncertainties of the various, of the various steps of analysis.

(Slide)

MR. BASDEKAS: Here we show the base, the results of the base case uncertainty results with and without operator action, again emphasizing the system sensitivity in operator errors, and just summarizes the bottom line data in terms of the mean values, the 5th and 95th and 50th percentiles. These were used later as you will see in the cost/benefit uncertainty analysis, and the results of that analysis are shown in the next slide.

(Slide)

MR. BASDEKAS: This vugraph shows both with and 13 without operator action on the cost/benefit in terms of dollars per person-rem reduction for each option along with the percent probability to be between zero and a thousand dollars and probability of to be more than a thousand dollars, and you can see that we have a wide variation in this, the distribution parameters in here.

On the next slide we make comparison of the point estimates and the uncertainty means. Here you will see we do have a--well, okay--here we have point estimate to mean, but to take it as the point estimate, the mean is there just for I guess, I think it slipped into our tabulation to indicate that we are going to make the point estimate, you hope you are close to the mean, but talk basically in one column we have the point estimate, in the other, the mean derived from the distributions, and the statistical analysis you perform on the data data that we analyzed, so in responding to or follow-up on Mr. Carroll's statement, it was this step of the results that prompted us to make judgments well, on all six, but I believe you referred to Option 3 that exhibited a point estimate favorable cost/benefit ratio, so based on the results we have seen, both in the statistical analytical sense, but equally important, if not more so, in the judgments we had and we did make, based on insights we have gained during this process of going through step by step and perform these analyses, we have concluded that there were no backfit requirements based on the requirements of the backfit rule or the guidelines, the guidance of the backfit rule.

However, as I indicated, a PRA analysis is useful in ways other than just the ability to come up with a set of numbers, is the opportunity that it offers you to gain insights of how the system works, where the sensitivities are, and how you can best fix it if you please to get the most benefit for the money, and based on this collective body of work and knowledge we derived from that, as I said earlier, we have come to the conclusion that no backfit requirements are warranted.

Okay. That's fine. And I think we have gone through some agonizing discussions--well, not very agonizing, but nonetheless, some, you know, extensive discussions as to why we should accept and what numbers we should accept as valid numbers, and where are those conclusions?

However, in the process of doing so, and based upon the insights we have gained, we felt that even though we can not impose regulatory requirements, it would have been wasteful if we did not make our insights available to other parts of the Agency, and indeed others for that matter, so this last vugraph here called further work, it is something that goes beyond the, you know, the strict resolution of this issue.

This issue we consider resolved which by taking, by proposing no new regulatory requirements. However, there is some related to this issue, activities going on within the Agency that we have been involved in helping formulate their actions, and/or vice-versa, getting inputs from them, namely and most specifically, Mr. Rosa here, and his people, and as well as another group within NRR dealing with revising technical specification test requirements and this type of thing, and too, the insights that we have gained prompted us

and it will bring to the attention and as you probably read in the draft document that we are submitting to EDO and the Director of NRR, we are bringing to their attention the fact that it will be worthwhile to have further activities that we have ongoing within the, within the Agency to consider these things that I list here, namely, the first one I believe that it will be very useful and perhaps productive to consider the, decreasing the reactor trip test frequency in conjunction with the addition of a trip function in the M/G set breaker or breakers as the case may be, either the breaker or the generator or, the output breaker or the generator for the M/G set, and this compensates for the increase in the interval between tests of the RTBS and perhaps at the same time, the
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increase of, somewhat the increase of the time out of service interval because of the industry has been making the point and the staff has been presented with the fact that if there is not enough time available for technicians to perform the tests and they are rushing, they are increasing the likelihood of making an error, and in the process, you know, causing a problem.

MR. LIPINSKI: If M/G trip causes a shutdown, you are going to do that once per refueling?

MR. BASDEKAS: As far as the--

MR. LIPINSKI: Testing.

MR. BASDEKAS: Not necessarily; you have this option. That's one, an option, but not necessarily because as a matter of fact, after the main study was completed, we asked Daniel to take a quick look at this and we have been provided with bypass arrangements. It will be costlier, but it can be done, can test it during operation.

MR. LIPINSKI: How are you going to bypass--

MR. BASDEKAS: Put in parallel breakers and parallel--and pretty much the same way you bypass the reactor trip breakers; very comparable arrangement.

MR. LIPINSKI: Okay.

MR. BASDEKAS: But it will cost more.

CHAIRMAN KERR: Is that the same, roughly the same sort of breaker that was being used in the existing trip circuit?

MR. BASDEKAS: No. They are different. Some of them use contractors, and if there isn't a--we have not come out and said here is Option 7 and we have done this and we have given one for a long time that, it was that--would not have at least for the short time that was available to us, and this was--as a matter of fact, during the last meeting we had to run off the resolution of this issue. Somebody came from Europe and pointed out that some European plant was using this, this approach to enhance the reliability and also extend the life of the HTGs.

CHAIRMAN KERR: What is the current, site current of the generator? Is it, it is not 600 amps?

MR. BASDEKAS: No. That is very small.

MR. WYLIE: Twenty maybe I guess.

CHAIRMAN KERR: It would be different?

MR. BASDEKAS: It is a different, all together different kind and different size.

CHAIRMAN KERR: Different breaker, not necessarily any more reliable, just depending on diversity here?

MR. BASDEKAS: That is exactly right.

MR. LIPINSKI: This is the GE fix to ATWS.

MR. BASDEKAS: Yes, sir, for recirculation pumps.

MR. LIPINSKI: They didn't want to interrupt the main current and they said gee, we can interrupt the field current, and that's where they stand.

MR. CARROLL: But in the case of Westinghouse, is this quick enough? How fast output voltage delay?

MR. BASDEKAS: That's one of things we have not been able to do yet. We did not go into this because we are getting--we decided to prolong the resolution of this issue and schedule, but they are not sacred, but we are getting to the point where we will be designing the system for a utility and we decided to, to look at the main pictures if you please or say shortcomings as the case may be of this particular scheme that at least one European plant has used, and bring it to the attention of our people in NRR and the industry, and we thought that would be a good example of industry initiatives to do more of the nitty-gritty type of work that along the lines you are asking your questions, and to come back with a proposal to the staff and say here is what we are proposing to do.

MR. LIPINSKI: Westinghouse plants can withstand--so whether it is a minute or not, immediate effect.

MR. BASDEKAS: The time will be short, but I don't know.

MR. LIPINSKI: You would like it to be as fast as your system if you have got a redundant diverse system. I don't know that we are talking about having it happen in milliseconds.

MR. CARROLL: Well, Westinghouse plants, based on ATWS considerations, can have a delayed SCRAM, but there are other things that we consider, like damage or overpower transients that result in--

MR. BASDEKAS: Mr. Carroll, I think the reason that we felt, the additional reason we felt more comfortable is we received unofficial, informal information, and that's why we are not presenting this part of our resolution package, okay. It is up to--the Europeans have gone through and given, tested the system.

MR. WYLIE: Basically what you are recommending is diverse--let me see if, let me state what I think you are recommending.

You are recommending a diverse system?

MR. BASDEKAS: No, we are not recommending.

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MR. MINNERS: We don't use the word recommend.

MR. BASDEKAS: Bring it to the attention of to consider.

CHAIRMAN KERR: Please let Mr. Wylie finish his statement before you respond to it.

MR. BASDEKAS: All right, sir.

MR. WYLIE: It says conclusion and recommendations in your--

MR. CARROLL: As we have the following recommendations.

MR. WYLIE: I assume you are recommending it.

MR. KNIEL: In this slide it says further work. We neglected to cross out the recommendation in the other part.

MR. WYLIE: What I am--as I understand it, what you are, you are recommending is a consideration of a diverse means of removing power to the control rods by the use of existing equipment in the plant.

MR. BASDEKAS: With some modifications.

MR. WYLIE: But it is the existing equipment, breakers or contactors or whatever it happens to be, between the field circuits or output breakers or M/G sets or whatever, but there are ways of doing that also like driving the voltage regulator to zero, for example.

MR. BASDEKAS: I'm not going to dispute there are ways.

MR. WYLIE: Yes, but I mean rather than prescribing a way to do it, it seems like to me you would prescribe the criteria you are trying to achieve, which is as I stated it, diverse means of removing the power from the control rods using the existing equipment as much as possible and let the applicants or the licensees come in with recommendation in which way they prefer to do it.

MR. BASDEKAS: Absolutely.

CHAIRMAN KERR: This apparently implies that either the number currently used for trip breaker reliability is inadequately large or it is too large, or else the uncertainty is too great or something. Otherwise you wouldn't need to do anything.

MR. BASDEKAS: Well, the--okay. I'm sorry.

MR. MINNERS: That is what we are proposing is to do nothing, okay, so you, I don't understand your statement. We are not proposing to do anything.

CHAIRMAN KERR: It says NRR--and that's not you I realize--NRR is considered decreasing the test frequency in conjunction with--

MR. MINNERS: Correct.

CHAIRMAN KERR: All right.

MR. MINNERS: Correct. So if people want, it is my understanding that people, licensees want to come in and increase their test interval, okay, as a compensating feature, people would say hey, put some more reliability into your system.

CHAIRMAN KERR: This is just for information? It says NRR is considering this?

MR. MINNERS: That's right.

CHAIRMAN KERR: Sort of an oh, by the way?

MR. MINNERS: That's right.

MR. BASDEKAS: Additional insights.

MR. MINNERS: That's the message we are trying to give you.

MR. BASDEKAS: The bottom line as far as the resolution of this issue goes, you know, we said the conclusion was that no backfit requirements are warranted, and we are away from that.

Now having said, that we are sharing some of the insights we have gained because we have seen documents within the Agency in the tech specs as well as the advanced reactor, light water reactor activities that these insights may have a constructive bearing on, and if it weren't, for instance, to prolong the useful life of the RTB if a utility wants to do that and they feel it is desirable to extend the test frequency in attempt for that, we have to do something else, and we are saying--

CHAIRMAN KERR: Let's suppose that one concludes that decrease in, increase in test frequency, in testing interval, made the breakers more reliable. Would you still want to do something?

MR. BASDEKAS: I understand, but I think this is perhaps that--

MR. MINNERS: Ask NRR.

MR. BASDEKAS: The NRR people are in the process of developing the bulletin along these lines, and perhaps Mr. Rosa, may wish to--

CHAIRMAN KERR: If they are in the process, I will wait.

MR. BASDEKAS: It is still a pre-decisional insight type of conversation still going on.

CHAIRMAN KERR: It is also true I think that NRR is looking at the question of should testing and power be decreased if feasible? And I certainly think that's a wise move.

MR. BASDEKAS: I'm sure that's part of it.

MR. WYLIE: What is the test rate now on the breakers?

MR. BASDEKAS: It's alternating every month. Every two months a breaker is tested.

MR. WYLIE: It is about six times a year?

MR. BASDEKAS: A year.

16 MR. OAKES: Demetrius, maybe I missed it in your write-up, but have you mentioned anywhere how the Europeans make the transition from the analog signals to making the interruption of the field coils or the output of the M/G, the parallel with the current UV cards or put in?

MR. BASDEKAS: Undervoltage, it is my understanding that they use the same undervoltage drivers to accomplish both trips if you please in parallel.

MR. OAKES: If that's the case, how does this change the basic reliability problem introduced by the unreliable UV card?

MR. BASDEKAS: It will make up--well, well, okay. Speaking of unreliability of UV card, we are saying that it will be prudent to consider it, implementation of Option 1, namely, the installing the Westinghouse cards that will be more reliable. And secondly, the, primarily thrust of adding of this parallel trip function to the M/G set breaker, okay, is to compensate for what the expectations will be to have a decrease in the reliability of the RTBs by increasing substantially perhaps the test interval.

MR. OAKES: Basically it looks like a good idea to me, and I would think it would go some distance in meeting Walt's earlier comment.

MR. BASDEKAS: That's why we, I said wait until the end and we can get down to some of the nitty-gritty discussion if necessary.

So basically, with this last slide, which we include our insights beyond the conclusion, which is basically the resolution of the issue of no backfit requirements; basically that's the extent of what we have done, and then some, okay. for resolving Generic issue 115.

This is basically the extent of the formal presentation, Dr. Kerr, and there is still some desire to hear the specifics of what we have done in analyzing common mode failures and the like for the reactor trip breakers.

CHAIRMAN KERR: You are going to tell me whether you looked at a common mode failure or--

R. BASDEKAS: Yes. Indeed I think that's the, the subject I think that is contained in a brief presentation that we asked Doctor, I meaning Mr. Reny to prepare.

CHAIRMAN KERR: I would certainly be interested in that. I don't know about my colleagues.

MR. MINNERS: Do you want to have that now?

CHAIRMAN KERR: If that is the only thing left, yes.

CHAIRMAN KERR: Let's take about a 15 minute break at this point.

(A brief recess was taken.)

CHAIRMAN KERR: Shall we continue? We lost the principle actor?

(There was a brief pause in the proceedings.)

CHAIRMAN KERR: Whenever you are ready Mr. Reny.

MR. RENY: Okay. The first question I think you wanted to have answers on was the reactor trip breaker reliability, and what we did with that in our analysis.

This is a simplified schematic of the Westinghouse system. There are two trip breakers that do the job. Each breaker has an undervoltage device, and the shunt trip device to actuate them. These devices work quite differently. The undervoltage device is a mechanical spring loaded type of device which is held back with a solenoid type of latch such that the 48 volts trip signal here is holding this device open, and when the signal is removed, the latch releases and the spring force causes the breaker to trip.

The shunt trip is different in the fact that it's a solenoid actuated device where 125 volts is applied through a relay which causes the shunt trip to actuate and trip the reactor.

The relay that actuates the shunt trip device is powered off of the undervoltage driver cards, the same 48 volts signal that supplies power to the undervoltage device.

(Slide)

MR. RENY: We took a look at the data and we took a look at it for the three devices--the undervoltage trip device on the breaker, the shunt trip device, and the actual remaining parts of the breaker, the mechanical actuation devices.

The NUREG 1000 study from the Salem events has 26 failures to open on demand and 6,000 estimated demands for the undervoltage trip device.

Now this was actually the entire reactor trip breaker failure data for Westinghouse because the undervoltage trip device at that time was the only device actuating the breaker, and all the failures were attributed to that device.

After the Salem ATWS events, we collected NPRDS data
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from 1984 through 1987 and we were able to find eight more events in approximately 4,000 estimated demands of undervoltage device failures. Now these were, were actual undervoltage device failures, but were not necessarily reactor trip breaker failures because of the fact that the shunt trip may or may not have been available during these breakers to actuate.

So if we combine these two sets of data, prior to 1983, and then '84 to '87, we come up with an undervoltage device failure rate here of 3.4 times ten to the minus 3. Rather now we took a look at shunt trip devices and prior to the Salem, event there was not any recorded history on shunt trip devices because they were not considered safety devices and information was not reported.

We did collect it for the same time period that we did for the UV device, from '84 to '87, and we found two failures and 4,000 demands, and associated failure rates. We collected other types of reactor trip breakers not associated with the UV device or the shunt trip device, and found an additional two failures in 4,000 demands that prevented the breaker from operating, and so we have a failure rate for that.

MR. CARROLL: How would those failure rates change as a result of the improved testing and maintenance that has gone on in the industry since the time of the Salem event?

MR. RENY: Well, in the undervoltage trip device, which was what most of the direction of the testing and maintenance was geared for, was for preventing that failure, we see a slight improvement in reliability at that particular device.

As far as the shunt trip or mechanical components, we have nothing to, no previous history really to base that on except for the fact that undervoltage trip device was by far the dominant and probably the only failure mode from breakers such that it failed so often that maybe it masked other types of failures the breaker might have had if it was able to operate longer, and we see some mechanical failures down here which were not present in data previous to '83.

MR. LIPINSKI: What were those mechanical failures?

MR. RENY: The McGuire event, which was a shaft weld failure which caused mechanical binding of the shaft, it was an event where both the undervoltage and shunt trip devices worked, but the shaft bound up and it never tripped.

MR. LIPINSKI: And the other one?

MR. RENY: The other one was a problem with a, a contactor in the trip breaker itself such that when the breaker is pushed into the cubicle, it makes contact with all of its electrical signals such that it tells the operators that everything is go, that it is sitting in position and it should work correctly, whereas in fact there was a mechanical failure in there with one of the, one of the contacts which prevented the breaker from operating, and was not shown up anywhere until they actually had a demand and the breaker didn't work, so this was another type of mechanical failure, but actually not due to the binding or the actual operating mechanism, but due to the breaker itself.

MR. LIPINSKI: How frequently are these breakers reacting?

MR. RENY: Quite frequently. There are 280 some odd maintenance reports or events in NPRDS which have to do with reactor trip breakers for all PWR plants over a three or four-year period, so any--and that's what has been reported, so each one of those actions means that breakers react in or out, worked on one way or another.

MR. LIPINSKI: The event you have observed here could be repeated as these breakers age?

MR. RENY: Definitely.

MR. WYLIE: Which event are you talking about?

MR. LIPINSKI: Business of racking it out, not having the contacts meet up after it is racked back into--

CHAIRMAN KERR: That turned out to be a mistake in construction as I remember, isn't that correct?

MR. RENY: I believe there was a QA problem with the breaker.

MR. WYLIE: You are talking about the two at McGuire?

MR. LIPINSKI: I am talking about the last one he

18 talked about, racked back in and it didn't make up--.

MR. WYLIE: I don't know about that.

CHAIRMAN KERR: The same one I saw; it turned out that they built something onto the enclosure that they weren't supposed to have built and it was interfering with the breaker activity, and that was corrected.

MR. LIPINSKI: It is not a question of a routine activity that says do this often enough and you can expect to see this again?

CHAIRMAN KERR: If you are thinking of the same one I am--I think that's the case.

MR. LIPINSKI: If it was a design deficiency, then it was corrected, that's one thing, but if we are seeing an event that occurs from racking inn and out, you can see it occur again in the future.

MR. WYLIE: Also the McGuire event as I recall was a quality control problem in the manufacturing of the breakers originally, wasn't it, where the shaft was out of round and caused a binding of the breaker? That was my recollection.

CHAIRMAN KERR: I'm sure you are right. I don't know whether you can avoid those or not.

MR. WYLIE: Well, yes. Well, well, as I recall the history of the thing, Westinghouse had switched their breaker manufacturing operation from Pittsburgh to Puerto Rico. They had a new factory start up. QA, QC was not that good, and they shipped a lot of breakers that had that problem that were poorly manufactured, and then when they ran into the problem, they then improved all of that, and they are now manufactured back at Pittsburgh on one of the reactor trip breakers that I think has taken care of that problem.

MR. BASDEKAS: It was a weld problem I think that caused--

MR. WYLIE: The ones I saw was the shafts that were out of round and somebody had taken a file to it, that kind of thing.

MR. RENY: To continue, so we took the data that we found and plugged it into our model.

(Slide)

MR. RENY: Our model currently shows the undervoltage trip coil and shunt trip coil in parallel such that either of the devices can actuate a breaker, and then the mechanical components in series there, these are the failures that regardless of the actuation mechanism, still cause failure of the breaker.

And we see here we have independent cut sets which are very small, which is current, which is consistent with the redundant model. We have common cause failure cut sets and the dominant one here being between the mechanical components, common cause failure of McGuire type event or the other type of event, here one times ten to the minus 5th; prior to Generic Letter 83-28, we only had the undervoltage trip coils actuating here on an automatic signal. The shunt trip was only actuated on a manual signal, so in that situation the undervoltage coils then were the dominant common cause failure.

Now with the shunt trip diversity in there, they are not the common cause dominant failure. The mechanical components are, and our model shows that because you need a common cause failure of both shunt trip devices and UV coil devices to have system failure now; the component failure data here from the previous chart, beta factors that were used for common cause failure.

MR. LIPINSKI: Where did you get the beta factors?

MR. RENY: The beta factors came primarily from the ATWS rulemaking analysis SECY document. I can't recall the number, and current PRAs, Seabrook being the latest one that had Westinghouse reactor trip breaker component failure history with a beta factor.

MR. LIPINSKI: Where is the justifications for the two others? You are saying you are lifting it from another report?

MR. RENY: There is no justification besides the fact that that was what was derived and used in the ATWS rulemaking.

MR. MINNERS: Have we ever had a common cause mechanical failure of breakers?

MR. RENY: No.

MR. MINNERS: We have had what, sir? We have had 6,000 operations?

MR. RENY: Ten thousand or more.

MR. MINNERS: Ten thousand operations?

MR. WYLIE: You know, Warren, that's a good question, but going back to the McGuire event now, the McGuire event was reported because the plant was starting up and then operational.

Now after that event, and they shipped some of those things back to Pittsburgh, they found the same thing on a lot of breakers and they corrected it, but they didn't get into

NPRDS because it wasn't in an operating plant, so I mean the potential is there, but that again is due to the manufacturing quality control, which--

MR. MINNERS: But they did catch it before they went into the plant.

MR. WYLIE: Well, it was during the investigation of the problem at McGuire that they looked at other breakers that they had on site and shipped them back up to Pittsburgh, they found the same thing, so the potential for common cause failure was there.

MR. CARROLL: This is other DB 50s that weren't used.

MR. WYLIE: Breakers at McGuire and Catawba hadn't been used yet.

MR. CARROLL: They were spares for reactor trip breakers?

MR. WYLIE: You have got two units. One unit started up and the other unit was sitting there.

MR. MINNERS: GE wasn't as lucky when they shifted their operation to Puerto Rico, and glued their breakers together on Monticello, you know, they had a, well, that plant hadn't started up, either. That was during testing, but that's what operating experience means. I mean however you catch it, that gets it included in operating experience. Agreed the potential is there, but there are already a lot of other controls and things going on and operating experience that just people--

CHAIRMAN KERR: And the potential doesn't count.

MR. MINNERS: No, I wouldn't say it doesn't count.

CHAIRMAN KERR: It doesn't count in beta. Potential doesn't.

MR. MINNERS: If it didn't count, we wouldn't have .02 here.

CHAIRMAN KERR: But that is not from beta.

MR. MINNERS: Correct.

MR. WYLIE: I think the point here, though, is that you found two failures out of so many from NPRDS, but the thing it didn't show was the number of failures that that same family of breakers had that they caught because of that failure that they did catch in operation.

MR. BASDEKAS: NPRDS were not the only source of data. We had the same for bulletins going out and this was another source of information that was going to these people to make sure that we are catching all relevant information as far as operations go.

MR. WYLIE: But I suspect in your data base is not the failures they caught when they were doing the testing of these Pittsburghs, that they didn't report them.

MR. BASDEKAS: That is correct. For those, that is correct.

CHAIRMAN KERR: Why don't you continue, Mr. Reny? I think we need a complete session some day on beta factors.

MR. RENY: The current method of deriving beta factors is somewhat uncertain. It is based on the potential for common cause, and that potential can be taken from a review of operating history failures.

For example, in the undervoltage trip device, we have a large number of failures, 30 or 40 different failures to look at, and we do have a common cause failure of the Salem events. That's a fairly high number. We have other types of devices like the shunt trip and the mechanical components, breakers that have very few failures to look at, one or two or so failures, and the potential has to be derived from looking at that experience here.

The current industry accepted method, though, has been to put some type of potential on there for a conservative appraisal or estimation of what the common cause contribution could be.

MR. DAVIS: I would like to say a couple of words about that. One of the numbers that gets used for beta factors frequently is .1, and that in fact was used in the Seabrook PRA as their generic beta factor.

Now they at the same time used different numbers where they had good data or where they thought they had good data, but their data base was developed by Lowe and Garrick and it's proprietary so I don't know that anyone has been able to really see it.

MR. RENY: I could shed some light on that. That .1 was derived as an average of the beta factors scaled for mainly mechanical components used in a typical BWR PRA, and the dominant contributors to that beta factor were high pressure injection pumps, RHR pumps, reactor trip breakers, and mechanical components of that type, so in my view, in this analysis, the .1 was not applicable to electrical components as such here, but more applicable to large mechanical components, somewhat applicable to electro-mechanical components.

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MR. DAVIS: Well, my only point was there is a reasonable base to argue for a .1. On the other hand, I'm not disagreeing that .02 is also reasonable.

Did you examine in your uncertainty analysis a range of beta factors?

MR. RENY: Yes.

MR. DAVIS: What was that range?

MR. RENY: We looked at a range I believe that went from .1 I believe at the top end to .005 at the low end.

MR. DAVIS: Thank you.

MR. RENY: I'm not exactly sure. I would have to refer back to the report.

MR. DAVIS: That would be a reasonable range.

CHAIRMAN KERR: Please continue.

MR. RENY: Well, basically that was now we modeled. The conclusion out of this was that prior to Generic Letter 83-28, the dominant failure mode was the undervoltage trip device. A single RTB had a failure rate in the order of four times ten to the minus 3. This number here for single RTB prior to Generic Letter 83-28 was reported as five times ten to the minus 3, and the ATWS study and the Salem study was on the order of 4.6 or 7 times ten to the minus 3 and the Seabrook PRA, so four to five times ten to the minus 3 is about the range for an undervoltage trip device.

With that the only device actuating the breaker, we had a high common cause of failure of the system due to both RTB failing due to the undervoltage trip device. After Generic Letter 83-28, the mechanical bind in the shaft mechanism and other types of failures dominate the failure mode. The single RTB failure rate now has increased by order of magnitude. By adding the automatic shunt trip device, the common cause failure of both RTBs is now in the order of ten to the minus 5th rather than ten to the minus 4th.

MR. LIPINSKI: Were they both used with the .02?

MR. RENY: This one was used with undervoltage trip device beta factor, and this one was used with the mechanical device beta factor, so this one has the .02 and this one has the .145.

MR. LIPINSKI: But in the top one, you also had to include a common cause for the trip breakers, too, in order to do your analysis dominated by the other one I assume .02 then, and then swamped by the undervoltage.

MR. RENY: That is correct. That would be included in here except for prior to Generic Letter 83-28 that mechanical failure mode was not exhibited.

CHAIRMAN KERR: Now if you take off your PRA hat and put on your, some other hat, you really believe that ten to the minus 5?

MR. RENY: Pardon me?

CHAIRMAN KERR: Do you believe that ten to the minus 5?

MR. RENY: Ten to the minus 5?

CHAIRMAN KERR: Yes.

MR. RENY: Current state of the knowledge, yes. With the automatic shunt trip device, what I believe is the relative difference between the numbers and not the absolute value. If you believe that the undervoltage trip device in the breaker prior to the automatic shunt trip device was this number, then I believe that after the automatic shunt trip device, it is this number.

MR. LIPINSKI: That says you have gotten rid of everything and you are just left with the mechanics.

MR. RENY: Basically, yes.

CHAIRMAN KERR: The reason I asked is because we demand quite a lot of these trip systems. We demand that they be more reliable than any other system in the reactor by at least an order of magnitude, and yet you tell me you are unwilling to comment on what you think the absolute number is or that's the number you used to arrive at these conclusions.

I am not being critical of you. I am simply saying that number sticks out it seems to me if you look at risk contributors to the reactor operations, not that it is necessarily wrong, but it places a very high reliability on a fairly important system, much higher than any other important system I know of.

MR. RENY: I agree, and there is some uncertainty included within all of these numbers. These are the point estimate numbers of which there are uncertainty bounds.

CHAIRMAN KERR: And I say this in context which I believe that something could be done about this in the next generation of reactors. I think you can design them so you don't have to depend on this system, but that's a side issue to this discussion.

MR. LIPINSKI: Take the mechanistic approach, failure of the single active component, calculate what you have left, it would be single breaker, forgetting about reliability.

CHAIRMAN KERR: I would hope that we abandon the single--okay.

Continue, please.

MR. RENY: Well, this was all I had to present on reactor trip breakers.

CHAIRMAN KERR: That's interesting. I'm glad to see what is there. I asked if somebody would comment on whether we looked at what I call at least the common mode failure such as overtemperature in these solid state devices causing the failure of air conditioning systems.

MR. RENY: We applied a beta factor for common cause failure across the logic components, and within the application of that beta factor would be included common cause effects such as common air conditioning failures and other type of environmental impacts.

A beta factor for a common cause includes all of the postulated common effects that could affect both of those components, so within that application, yes, the beta factor does account for possible environmental conditions affecting common cause failure, both logic components.

CHAIRMAN KERR: I assume you would give me the same answer if I asked you lightning and electrical surges?

MR. RENY: That is correct.

CHAIRMAN KERR: You wouldn't feel good about that answer, though, would you?

MR. RENY: No. A beta factor is a catchall.

CHAIRMAN KERR: Has there been any serious work on the affect of lightning on some of the solid state components generally, not restricted to this? I ask out of ignorance. Has the staff--

MR. ROSA: This is Faust Rosa again.

CHAIRMAN KERR: I don't mean lightning direct strikes, but lightninginduced transients.

MR. ROSA: The best study we have is the EMP study, and that indicated that lightning, well, that lightning that strikes out in the switch yard or on the distribution system from a switch yard to the first transformer is less severe from the standpoint of the transient input into the plant than an EMP pulse, and therefore, the EMP study indicated that we had nothing to fear from the EMP transmitted into the plant on the power system.

Now those failures of instrumentation channels that have occurred due to lightning strikes were primarily due to strikes on a containment building which somehow or other reached the penetration areas and directly impinged on the circuits in those instruments.

CHAIRMAN KERR: So they don't count?

MR. ROSA: They count yes, sir, but every time it happens, the licensees are required to upgrade their lightning protection system on that particular building, and that's it.

MR. RENY: I might add that the logic channels are isolated from the analog instrumentation such that that pulse could not be propagated through.

CHAIRMAN KERR: It is the position of the staff then that the solid state circuitry, generally solid state components are no more vulnerable to lightning-induced pulses, analog instrumentation or whatever?

MR. ROSA: Given the surge protection devices that are in series with the power circuits yes.

CHAIRMAN KERR: Are there further questions?

MR. CARROLL: What has been the utilities' experience in using solid state transmission protection devices as far as lightning is concerned?

Has that been generally favorable, or has that been looked at in terms of lightning?

MR. BASDEKAS: I don't believe we have an answer for that, Mr. Carroll, but we will try to get you one.

As Mr. Rosa outlined earlier, there is, there are requirements for such protection throughout the plant. I do recall there were some operational experiences involved in the use of walkies-talkies in control room proximity, and those problems were resolved many years ago as part of the FFTF start-up experience in other plants I'm sure, but nonetheless, I think these are very good, you know, technical problems to work on, but as far as the scope of this particular issue, as I was careful to point out at the beginning, it was rather

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limited to address 70 percent that stemmed from the Salem events and subsequent operational experience with the drivers, but nonetheless, your concern is well taken.

CHAIRMAN KERR: Further questions?

MR. CARROLL: Just for my edification Bill--I don't know if others want to hear it or not, but I guess I would like to understand a little better the situation on the Combustion and B&W plants, just for background purposes.

CHAIRMAN KERR: Insofar as the solid state device is concerned? They don't use them, do they?

MR. BASDEKAS: I'm sure they use them, yes.

MR. WYLIE: I think B&W originally used extensive solid state logic in the protection systems.

CHAIRMAN KERR: Did they use this kind of card?

MR. WYLIE: I don't know about this specific card.

CHAIRMAN KERR: This is a rather specialized--

MR. BASDEKAS: Westinghouse plants specifically I think; as far as Westinghouse plants go, but to the best of my knowledge--

MR. CARROLL: You are happy with what both Combustion and B&W have in their circuitries similar to this?

MR. BASDEKAS: No, we are not saying that, Mr. Carroll. Personally I cannot voice an opinion on the relative merits of other designs. Perhaps someone else here might shed some light, but this issue was oriented specifically toward

Westinghouse plants.

MR. DAVIS: I think the other designs with, by ATWS rule to have a diverse mechanism--

MR. BASDEKAS: For installing a totally diverse parallel system and that will take away a lot of the--

MR. DAVIS: Westinghouse was exempted from that requirement on the basis of--

MR. BASDEKAS: Yes.

MR. CARROLL: Exempted on the basis?

MR. DAVIS: On the basis of their enhancability to ride through it like a SCRAM and installation of the automatic feedwater--

MR. BASDEKAS: And turbine trip.

MR. WYLIE: B&W plants originally had a driver trip system as their original design.

MR. ROSA: That's right.

MR. LIPINSKI: The Combustion Engineering plant at Arkansas has the protection system and it is very similar and the equipment was in the same room, had an air conditioner oversize link, were getting spurious trips.

MR. BASDEKAS: Some events as recent as last month or so continue to exist for that type of system.

CHAIRMAN KERR: Further questions or comments? Mr. Reny, did I understand correctly that the staff did look at the possibility of replacing or that you did perhaps, the undervoltage coil and another shunt coil and have concluded that because of common mode failures, that that would actually decrease reliability?

MR. RENY: That is correct, and I wanted to address that. The model for that option looked like this except there was a shunt trip here and a shunt trip here, double redundant shunt trip devices on each breaker.

Now if you follow the beta factor methodology, you would have to assume a common cause failure mode between those four shunt trip devices where, whereas with an undervoltage and a shunt trip coil those devices, being diverse, you would assume no common cause failure modes between those two. Therefore, the assumption of the common cause failure mode between like devices there would have an additional contribution to common cause failure over here, which made it a slight increase in unreliability.

CHAIRMAN KERR: I just wanted to to make sure I understood the conclusion and the basis for it.

MR. MINNERS: Do you use the .145?

MR. RENY: For shunt trip? We used the .065 for shunt trip. However, that number was used for the likelihood of failure of two shunt trips. We used the number slightly smaller by a factor of ten for the likelihood of failure of three or more, four shunt trip devices, so it followed what is called the multiple Greek letter method, which is an extension of beta factor to higher redundancy systems.

CHAIRMAN KERR: Suppose instead of using it to control the reactor, you were using it say to control your furnace at home? Which of these two systems would you refer? The one with four shunt trips, or one with two undervoltage trips and two shunt trips?

MR. RENY: I would prefer the diverse system, this one undervoltage and shunt.

CHAIRMAN KERR: You are consistent anyway.

MR. RENY: I think the diversity has a lot of merit as far as preventing common cause failure, failure mechanisms, and at this point in time, that seems to be the extent of the defense for common cause is its diversity.

CHAIRMAN KERR: I agree with you wholeheartedly. The diversity can prevent certain kinds of common cause failures, but my objective is reliability rather than diversity, and I'm not sure that they increase the reliability, but maybe it does.

Any further questions? Well, that concludes the staff's presentation. I want some comments from some of you, but I'm sorry that we took up most of Mr. Kniel's and his colleagues this afternoon, but it has at least been educational for us, and perhaps we have a better understanding of the logic.

Personally I have no quarrel with the decision that was reached on this rather narrowly defined generic issue on the basis of what occurred, but--and I think that's enough recording. Thank you ma'am.

MR. WYLIE: Someone mentioned that the staff was prepared to tell us something about the recommendation regarding some testing of the reactor trip breakers? Somebody? Anybody in Research or something?

MR. ROSA: We had a research review group meeting last, two weeks ago during which part of the--well, on aging. It was a three-day meeting, and one of the presentations described the life testing that was being performed on some SCRAM breakers. They were Westinghouse DS type breakers. I forget exactly what the number, but that's intended to, to arrive at a, at a life test based on how many cycles the breakers can withstand, given periodic mechanical maintenance. That test will not, will not take into account the undervoltage trip attachment or the shunt trip attachment reliability.

MR. WYLIE: What is the purpose of the test?

MR. ROSA: Just to arrive at a, a number of life cycles for the mechanical portions of the breaker.

MR. CARROLL: So you are simulating the actual surveillance test on the breaker where you are not interrupting current?

MR. ROSA: That's essentially it, yes. Current interruption capability has never been a problem on reactor trip breakers to my knowledge.

MR. WYLIE: These breakers.

MR. ROSA: The actual contact.

MR. WYLIE: It is a very large breaker current-wise. As I recall, 1200 amps, something like that; only seeing what, less than six I guess?

MR. ROSA: Yes.

MR. LIPINSKI: Is this a single breaker?

MR. ROSA: I believe they are testing three breakers, two or three types.

MR. LIPINSKI: And they came out of the shop, the best QA?

MR. BASDEKAS: No, no. They had some already for their own use at laboratory and pulled them out, spares or whatever, and tested them and DB 50s DS 3416s and otherwise.

MR. LIPINSKI: Random sample; it is not the best.

MR. WYLIE: It is interesting they are testing only the breakers itself rather than undervoltage device which has been really the culprit.

MR. ROSA: Well, I believe it is considered that the undervoltage device unreliability has been pretty well established.

MR. WYLIE: I don't know whether it has with age or not. It may get better with age. I don't know.

MR. CARROLL: Make it smarter in terms of--

MR. LIPINSKI: Whether they are physically tripping the breaker; they have got to get in there somehow.

MR. POSA: I believe they have rigged up some sort of electro-mechanical trip device; probably just a shunt trip.

MR. LIPINSKI: Something special; isn't normal tripping.

MR. WYLIE: They were using the shunt trip. That ought to give you some better indication of the reliability of the shunt trip, which I would suspect is much better than the numbers we have seen here frankly because when this problem came up with the reactor trip breakers, I had never heard of these type of breakers ever failing to trip.

MR. ROSA: The age research program is rather extensive. Each element of it is going to produce a separate NUREG report so we will have all of that data when they get finished.

MR. CARROLL: DB 50s have a bad name in fossil plants.

MR. WYLIE: I guess depending how they maintain--

MR. OAKES: What is the environment?

MR. ROSA: Oh, probably just a shop environment. I don't know any of the details. They do intend to perform the periodic maintenance that they expect a good utility would perform while they are doing this.

MR. CARROLL: How do you define that? We are going to talk about the maintenance rule tomorrow.

MR. ROSA: I don't know. We will have to wait for that research report.

MR. OAKES: What is the definition of a failure? The time response becomes too long, or has that been established?

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MR. ROSA: The presentation did cover that. I would expect just an immediate opening would be all that's required. You don't expect any, any delay in the actuation. It is like you get with the undervoltage trip attachment when it gets hung up. I couldn't give you the details on that.

MR. OAKES: Are they expecting to do any incipient failure diagnosis on the test?

MR. ROSA: I don't know. The periodic examinations that will be conducted during the maintenance periods during the tests will look for incipient failures like cracking welds or cracked welds or things that nature.

MR. WYLIE: While we are talking about breakers, I talked to the maintenance people at Oconee and they had problems with those. Now those are GEA 25 breakers, which is smaller breakers than these DB 50s, but they had considerable problems with them, and their problem was just the breaker itself. The frame was not substantial enough. When you took it out and you calibrated it on the test bed, that would test perfectly. Then you put it back into the breaker rack, it would just warp enough it would change the setting, and they had--I don't know whether they still have a problem. They had extensive problems with those breakers because of that.

MR. ROSA: I might add one other bit of information. You know, NRR contacted Westinghouse management some months ago about QA problems in their, in their breaker manufacturing facilities, and Westinghouse came in and made a presentation and they described how breakers coming off the, their regular production line in Puerto Rico or wherever before being sold to a nuclear utility for application in the safety-related circuit go through a special inspection and test at Westinghouse right on the outskirts of Pittsburgh, so to that extent, that QA problems for safety-related breakers are being corrected by Westinghouse.

MR. CARROLL: There is a potential gap in all of that. Does the utility industry know that there are two kinds of DB 50s? The one that has got special nuclear treatment and the ones that they might have bought for a fossil plant and have urgent need at a nuclear plant and said a DB 50 is a DB 50?

MR. WYLIE: That has an N stamp on it.

MR. CARROLL: Not necessarily from what he described.

MR. MINNERS: I don't think that--

CHAIRMAN KERR: Any further questions relating to the issue at hand?

We have scheduled an hour for discussion of this issue at the Full Committee meeting. Do we need to ask the staff for a presentation or can the Subcommittee handle the discussion?

MR. WYLIE: I would recommend the staff might have a presentation, 45 minutes or whatever.

CHAIRMAN KERR: Is the staff willing to do that? Okay. I think with not a great deal of condensation if those present today will keep quiet at the Full Committee meeting, you can cover most of the material that you covered in your presentation. I can't promise that they will.

MR. CARROLL: I wish Lewis had been here before you made that assessment.

CHAIRMAN KERR: Lewis will have different questions. They won't be the ones that they raised today. Do we need to cover anything else? Okay.

MR. BASDEKAS: For the purchase of the presentation to the Full Committee meeting, you normally allow 50 percent of the time for questions and discussion and 50 percent of the time for presentation.

Would it be then appropriate to gauge say half an hour presentation and half an hour discussion or thereabouts?

CHAIRMAN KERR: I would say about 35 minutes of presentation, and hope.

MR. BASDEKAS: We may have to condense some of the slides that we have.

CHAIRMAN KERR: I think so.

MR. BASDEKAS: Thanks.

CHAIRMAN KERR: Again, we thank you for coming, and for the presentation.

MR. BASDEKAS: Thank you.

CHAIRMAN KERR: No more recording.

(Whereupon, at 3:30 p.m., the recorded portion of the meeting was adjourned.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of: ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Name: SUBCOMMITTEE ON INSTRUMENTATION AND CONTROL SYSTEMS

Docket Number:

Place: Bethesda, Maryland

Date: April 5, 1989

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken stenographically by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

/s/ Catherine S. Boyd

(Signature typed): CATHERINE S. BOYD

Official Reporter

Heritage Reporting Corporation

A PRESENTATION TO THE SUBCOMMITTEE ON INSTRUMENTATION AND CONTROL SYSTEMS ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

ON

THE PROPOSED RESOLUTION OF GENERIC ISSUE 115 ENHANCEMENT OF THE RELIABILITY OF THE WESTINGHOUSE SOLID STATE PROTECTION SYSTEM

APRIL 5,1989

BY

DEMETRIOS L. BASDEKAS

REACTOR AND PLANT SYSTEM BRANCH

DIVISION OF SAFETY ISSUE RESOLUTION

OFFICE OF NUCLEAR REGULARTORY RESEARCH

GENERIC ISSUE 115 DESCRIPTION

BACKGROUND

- SALEM ATWS EVENTS AND GENERIC LETTER 83-28
- SHUNT TRIP COIL GIVEN AUTOMATIC TRIP SIGNAL
- UV DRIVER CARDS IN W SHOW PROBLEM
- NRC STAFF AND W RECOMMEND IMPROVEMENTS

OBJECTIVE

- EVALUATION OF CERTAIN OPTIONS TO ENHANCE THE RELIABILITY OF THE W SOLID STATE PROTECTION SYSTEM (SSPS) AND THEIR POTENTIAL FOR RISK REDUCTION

OPTIONS EVALUATED

OPTION NO.	DESCRIPTION
1	UV DRIVER CARD MODIFICATION RECOMMENDED BY WESTINGHOUSE
2	DIVERSE UNDERVOLTAGE DRIVER
3	DIVERSE RTB ACTUATION MECHANISM
4	DIVERSE SSPS TRIP LOGIC AND UV TRIP FUNCTION
5	DUAL SHUNT TRIP ACTUATION FOR EACH RTB (REPLACING UV COIL)
6	REPLACEMENT OF ONE RTB WITH A CONTACTOR

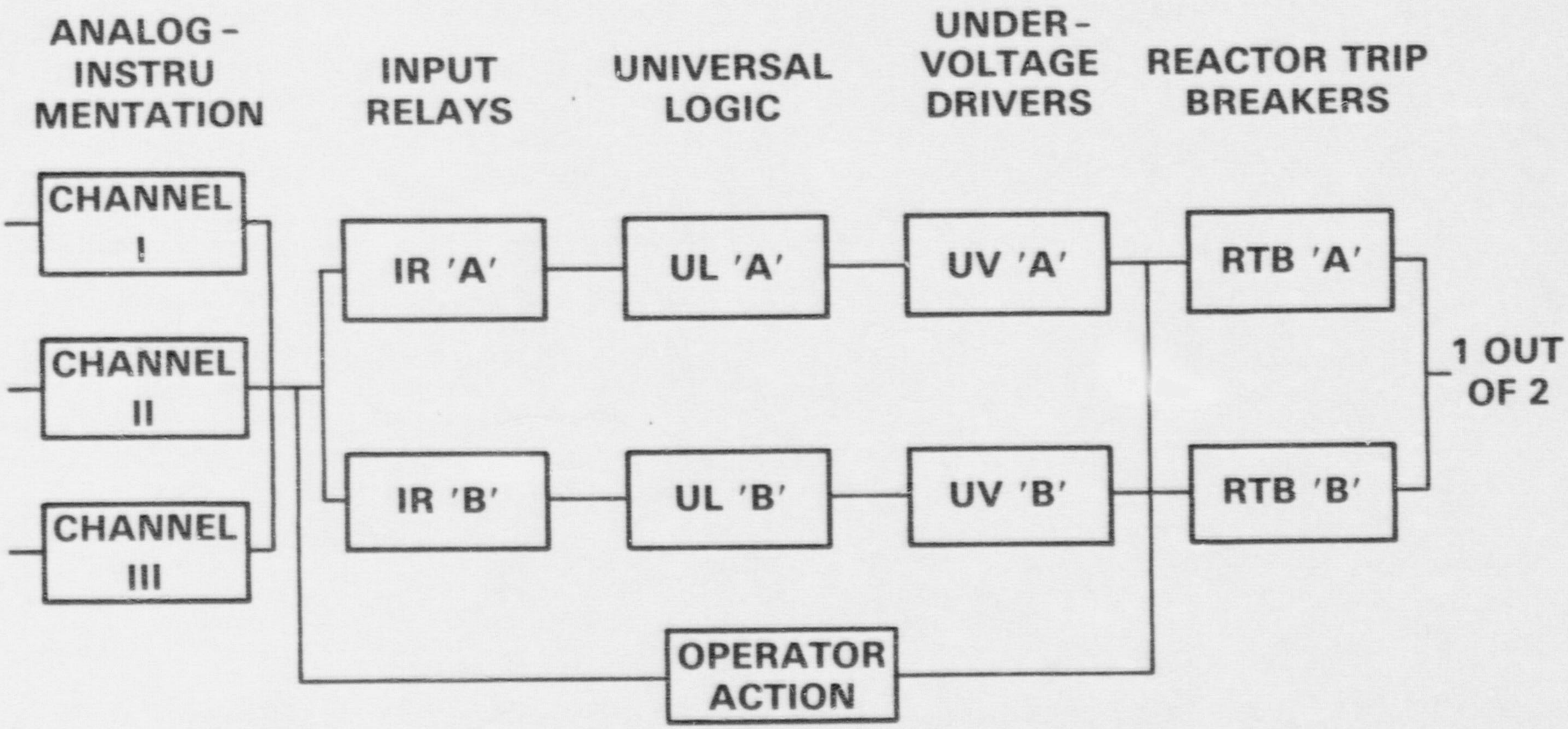
BASIC APPROACH

- COST/BENEFIT METHODOLOGY
- REACTOR TRIP RELIABILITY (BASE CASE AND OPTIONS)
- CONSEQUENCE ANALYSIS
- COST ANALYSIS
- UNCERTAINTY AND SENSITIVITY ANALYSIS
- DIVISION RATIONALE/RECOMMENDATIONS

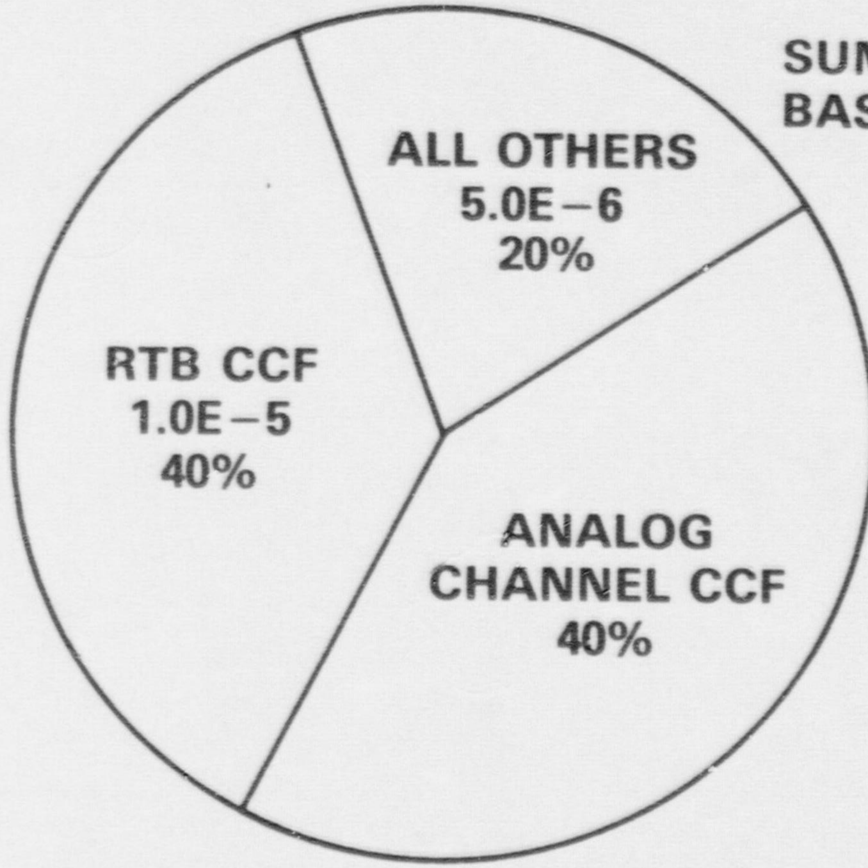
REACTOR TRIP RELIABILITY

- EVALUATED BASE CASE AND 6 OPTIONS
- BASE CASE CONFIGURATION INCLUDES AUTOMATIC SHUNT TRIP
- ASSUMED ALL ELECTRIC POWER SOURCES ARE AVAILABLE
- ASSUMED CONTROL ROD INSERTION IS SUCCESSFUL (NO FAILURE CONTRIBUTION) IF REACTOR TRIP IS INITIATED

REACTOR TRIP RELIABILITY BLOCK DIAGRAM



BASE CASE REACTOR TRIP UNRELIABILITY RESULTS WITH OPERATOR ACTION



SUM FOR
BASE CASE = 2.5E−5/d

CCF= COMMON CAUSE FAILURE

REACTOR TRIP UNRELIABILITY RESULTS

- CALCULATED RELIABILITY WITH AND WITHOUT OPERATOR ACTION (FAILURES PER DEMAND)

- BASE CASE CONTRIBUTORS

BASE CASE CONTRIBUTORS	WITHOUT OPERATOR ACTION	WITH OPERATOR ACTION
— COMMON CAUSE FAILURES (CCFs)		
ANALOG INSTRUMENTATION CHANNELS	1.0E-5	1.0E-5
UNIVERSAL LOGIC CARDS	1.0E-5	7.3E-7
REACTOR TRIP BREAKERS	1.0E-5	1.0E-5
UNDERVOLTAGE DRIVER CARDS	6.1E-6	4.3E-7
INPUT RELAYS	1.1E-6	7.5E-8
— ALL OTHER FAILURES	1.3E-5	4.1E-6
TOTAL	5.0E-5	2.5E-5

REACTOR TRIP RELIABILITY RESULTS (CONT'D)

- **OPTIONS CONTRIBUTIONS**

	OPTIONS (WITH OPERATOR ACTION)					
– COMMON CAUSE FAILURES (CCFs)	1	2	3	4	5	6
ANALOG INSTRUMENTATION CHANNELS	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5	1.0E-5
UNIVERSAL LOGIC CARDS	7.3E-7	7.3E-7	7.3E-7	~0	7.3E-7	7.3E-7
REACTOR TRIP BREAKERS	1.0E-5	1.0E-5	0	1.0E-5	1.1E-5	0
UNDERVOLTAGE DRIVER CARDS	8.6E-8	0	4.3E-7	~0	4.3E-7	4.3E-7
INPUT RELAYS	7.5E-8	7.5E-8	7.5E-8	7.5E-8	7.5E-8	7.5E-8
– ALL OTHER FAILURES	4.1E-6	4.0E-6	4.5E-6	3.0E-6	8.5E-6	3.8E-6
TOTAL	2.5E-5	2.4E-5	1.5E-5	2.3E-5	2.9E-5	1.5E-5
△ FROM BASE CASE (2.5E-5)	−5.4E-7	−1.0E-6	−1.1E-5	−2.0E-6	+4.0E-6	−1.0E-5

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CORE DAMAGE FREQUENCY RESULTS

CORE DAMAGE FREQUENCIES[a] (EVENTS/REACTOR YEAR)

	BASE CASE	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5	OPTION 6
WITHOUT OPERATOR ACTION TO MANUALLY SCRAM	9.9E-6	8.3E-6	7.9E-6	7.5E-6	4.8E-6	1.1E-5	8.1E-6
CHANGE IN CORE DAMAGE FREQUENCY	–	1.6E-6	2.0E-6	2.4E-6	5.1E-6	−1.1E-6	1.8E-6
WITH OPERATOR ACTION TO MANUALLY SCRAM	5.0E-6	4.9E-6	4.8E-6	2.9E-6	4.6E-6	5.9E-6	2.9E-6
CHANGE IN CORE DAMAGE FREQUENCY	–	1.0E-7	2.0E-7	2.1E-6	4.0E-7	−9.0E-7	2.1E-6

[a] FOR COMPARISON, THE ATWS GOAL ESTABLISHED BY THE NRC IS 1.0E-5 EVENTS/REACTOR YEAR (REF. 12 NUREG-1341)

COST/BENEFIT EVALUATION METHODOLOGY

SPECIFIC ANALYSES:

- REACTOR TRIP RELIABILITY ANALYSIS
- ATWS EVENT SEQUENCE (CORE DAMAGE) ANALYSIS
- GENERIC CONSEQUENCE ANALYSIS
- PROPOSED OPTIONS COST ANALYSIS
- PROPOSED OPTIONS COST/BENEFIT RESULTS

APPROACH:

- VARY REACTOR TRIP RELIABILITY AND COST FOR EACH OPTION AND HOLD REST OF PARAMETERS CONSTANT
- EVALUATE OPTION DELTAS FROM THE BASE CASE

COST RESULTS

COST PER PLANT ($K)

OPTION	LOW	BEST	HIGH
1	33	50	166
2	43	81	298
3	72	132	379
4	795	1,084	2,296
5	109	201	475
6	130	243	531

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COST-BENEFIT INCLUDING AVERTED ONSITE COSTS ($/PERSON-REM REDUCTION)[a]

	COST $K[b] (30 PLANTS)	PERSON-REM REDUCTION WITHOUT OPERATOR SCRAM (30 PLANTS)	COST-BENEFIT ($/PERSON-REM)	COST $K[b] (30 PLANTS)	PERSON-REM REDUCTION WITH OPERATOR SCRAM (30 PLANTS)	COST-BENEFIT ($/PERSON-REM)
OPTION 1	1,020	3,189	320	1,470	193	7,616
OPTION 2	1,830	3,944	464	2,394	242	9,893
OPTION 3	3,240	4,700	689	3,360	4,036	833
OPTION 4	31,000	10,000	3,100	32,398	673	48,140
OPTION 5	5,751	−1,869	—[c]	5,757	−1,803	—[c]
OPTION 6	6,750	6,504	1,038	6,690	4,112	1,626

[a] THE RESULT OF SUBTRACTING THE AVERTED ONSITE COSTS CHANGES THE COST-BENEFIT RESULTS. IT DOES NOT CHANGE THEIR POSITION RELATIVE TO THE $1,000/PERSON-REM NOMINAL COST—BENEFIT SCREENING VALUE

[b] USING COST FROM TABLES 4 AND 5 OF NUREG 1341

[c] NO BENEFIT

UNCERTAINTY ANALYSIS

RISK UNCERTAINTY — MODELING UNCERTAINTY

- REACTOR TRIP RELIABILITY MODEL
- ATWS EVENT SEQUENCE MODEL
- CONSEQUENCE ANALYSIS

— DATA UNCERTAINTY (QUANTITATIVELY EVALUATED)

- ALL DATA USED IN QUANTIFICATION

RISK UNCERTAINTY — BASE CASE RISK UNCERTAINTY − OPTION RISK UNCERTAINTY = Δ RISK UNCERTAINTY

COST UNCERTAINTY — ALL COST DATA (QUANTITATIVELY EVALUATED)

COST/BENEFIT UNCERTAINTY — $\dfrac{\text{COST UNCERTAINTY}}{\Delta\ \text{RISK UNCERTAINTY}}$

DATA UNCERTAINTY CALCULATION

A. $\text{UNC}\left[\begin{array}{c}\text{REACTOR TRIP}\\ \text{UNRELIABILITY}\\ \text{(PER DEMAND)}\end{array} \times \begin{array}{c}\text{INITIATING}\\ \text{EVENT SEQUENCES}\\ \text{(DEMANDS PER}\\ \text{REACTOR YEAR)}\end{array}\right] = \text{UNC}\left[\begin{array}{c}\text{CORE DAMAGE FREQUENCY}\\ \text{(EVENTS PER REACTOR YEAR)}\end{array}\right]$

B. $\text{UNC}\left[\begin{array}{c}\text{CORE DAMAGE FREQUENCY}\\ \text{(EVENTS PER FACTOR}\\ \text{YEAR)}\end{array} \times \begin{array}{c}\text{CONSEQUENCES}\\ \text{(PERSON-REMS PER}\\ \text{EVENT)}\end{array} \times \begin{array}{c}\text{REACTOR YEARS}\\ \text{(ALL PLANTS)}\end{array}\right] = \text{UNC}\left[\text{RISK}\right]$

C. $\text{UNC}\left[\text{BASE CASE RISK} - \text{OPTION RISK}\right] = \left[\Delta\text{RISK}\right]$

BASE CASE RISK UNCERTAINTY RESULTS

- RISK CALCULATED FOR REMAINING LIFE OF ALL 30 PLANTS
- MONTE CARLO UNCERTAINTY WITH 3000 TRIALS

UNCERTAINTY DISTRIBUTION RESULTS (PERSON-REMS)

	MEAN	5TH	50TH	95TH
WITH OPERATOR ACTION	16,831	600	5,700	59,100
WITHOUT OPERATOR ACTION	28,561	1.100	10,900	108,600

COST-BENEFIT UNCERTAINTY RESULTS

COST/BENEFIT ($/PERSON-REM REDUCTION)

OPTION	DISTRIBUTION PARAMETERS MEAN	5TH	50TH	95TH	% PROBABILITY FROM $0 TO $1,000	% PROBABILITY MORE THAN $1,000
WITHOUT OPERATOR ACTION						
1	6,750	201	2,280	26,200	26	74
2	10,020	278	3,320	38,300	20	80
3	22,100	600	6,010	85,600	8	92
4	42,200	1,300	14,300	167,000	4	96
5	NO POSITIVE BENEFIT					
6	131,000	7,100	70,900	505,000	0	100
WITH OPERATOR ACTION						
1	146,000	4,430	44,000	579,000	0	100
2	159,000	4,600	50,600	649,000	0	100
3	78,000	3,400	33,900	301,000	1	99
4	526,000	17,300	171,000	2,030,000	0	100
5	NO POSITIVE BENEFIT					
6	127,000	4,100	41,400	467,000	0	100

POINT ESTIMATE/UNCERTAINTY RESULTS COMPARISON

OPTION	COST/BENEFIT ($/PERSON-REM REDUCTION) POINT ESTIMATE MEAN	COST/BENEFIT ($/PERSON-REM REDUCTION) DISTRIBUTION MEAN
WITHOUT OPERATOR ACTION		
1	320	6,750
2	464	10,200
3	689	22,100
4	3,100	42,200
5	NO BENEFIT	NO BENEFIT
6	1,038	131,000
WITH OPERATOR ACTION		
1	7,616	146,000
2	9,333	159,000
3	883	78,200
4	48,140	526,000
5	NO BENEFIT	NO BENEFIT
6	1,626	127,000

CONCLUSION

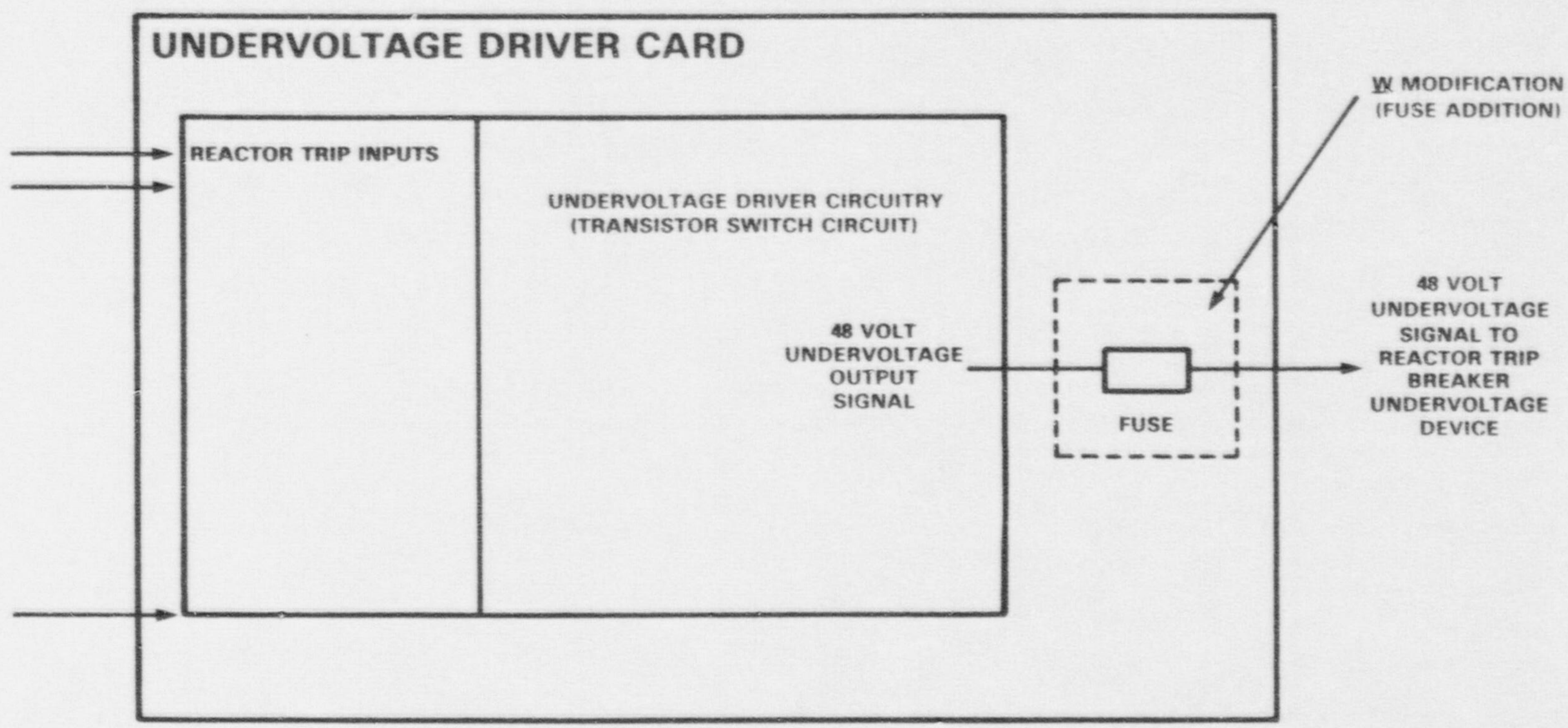
- NO BACKFIT REQUIREMENTS ARE WARRANTED

FURTHER WORK

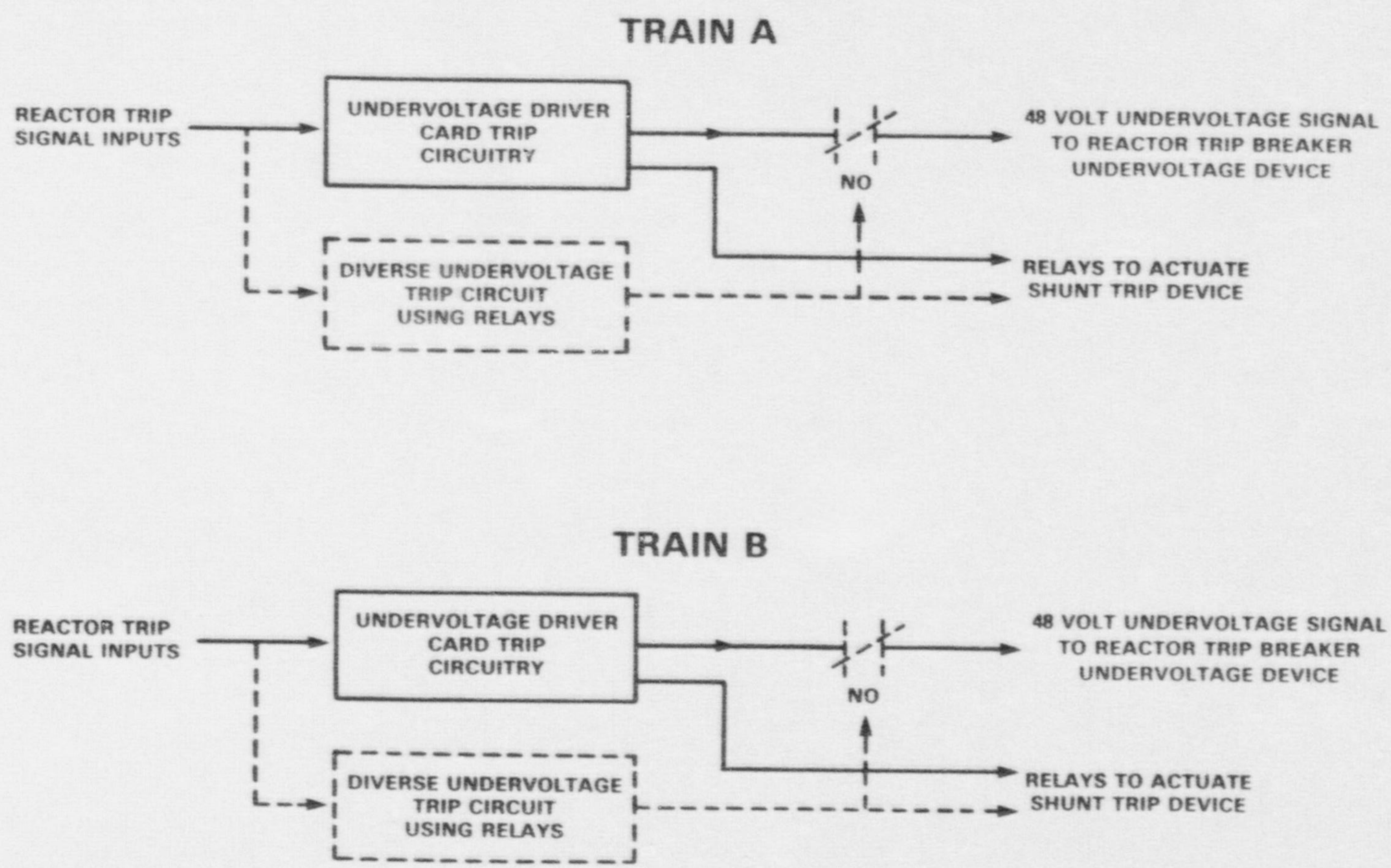
- NRR CONSIDERING DECREASING THE RTB TEST FREQUENCY IN CONJUNCTION WITH ADDITION OF M/G SET BREAKER TRIP FUNCTION (DESIGN ADOPTED IN A EUROPEAN PLANT)
- IMPLEMENTATION OF OPTION 1 REQUISITE FOR ADDITION OF M/G SET BREAKER TRIP
- NRR CONSIDERING ABOVE OPTIONS FOR ALWR

BACKUP VIEWGRAPHS

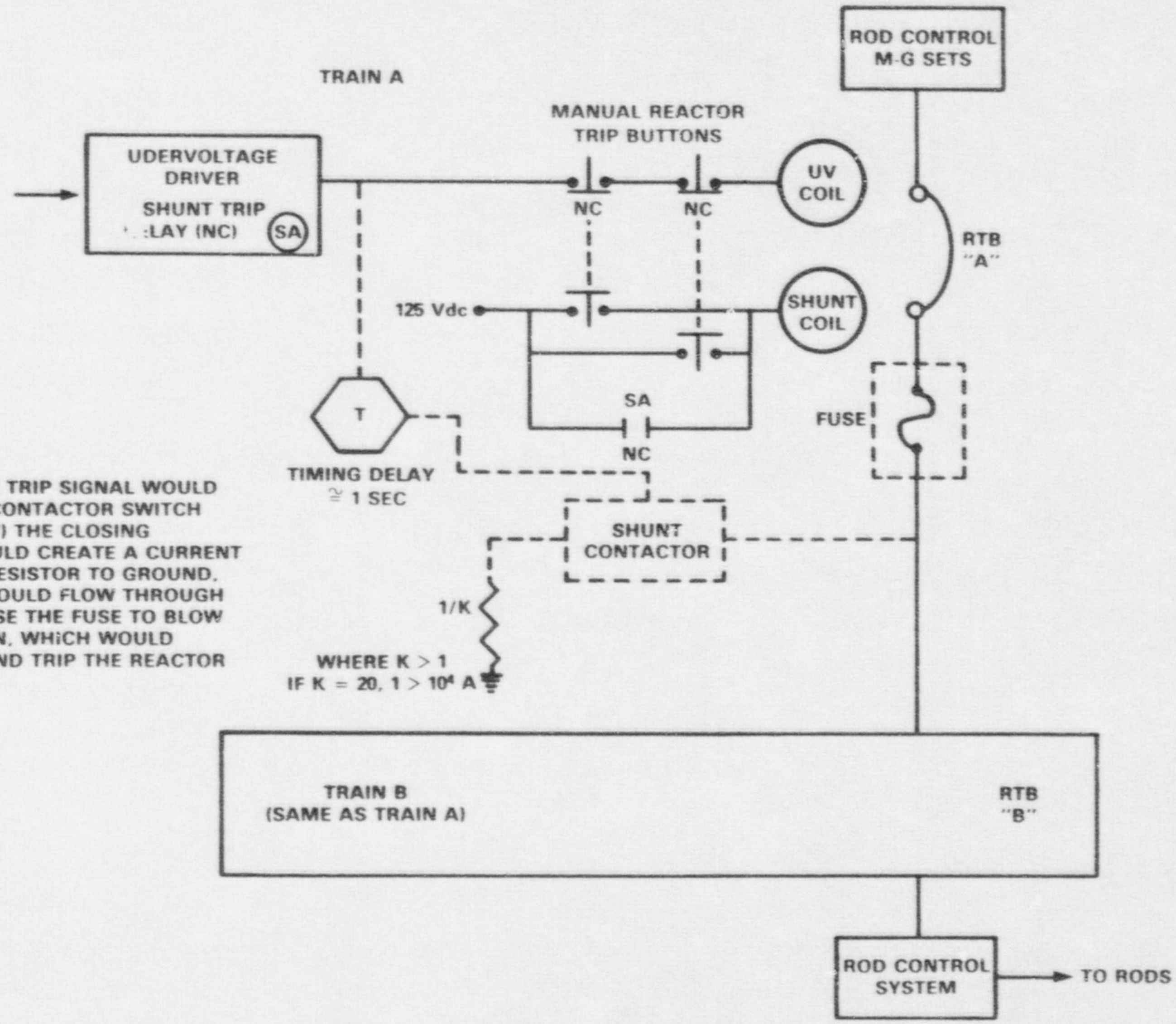
OPTION 1-UV DRIVER CARD MODIFICATION RECOMMENDED BY WESTINGHOUSE



OPTION 2-DIVERSE UV DRIVER

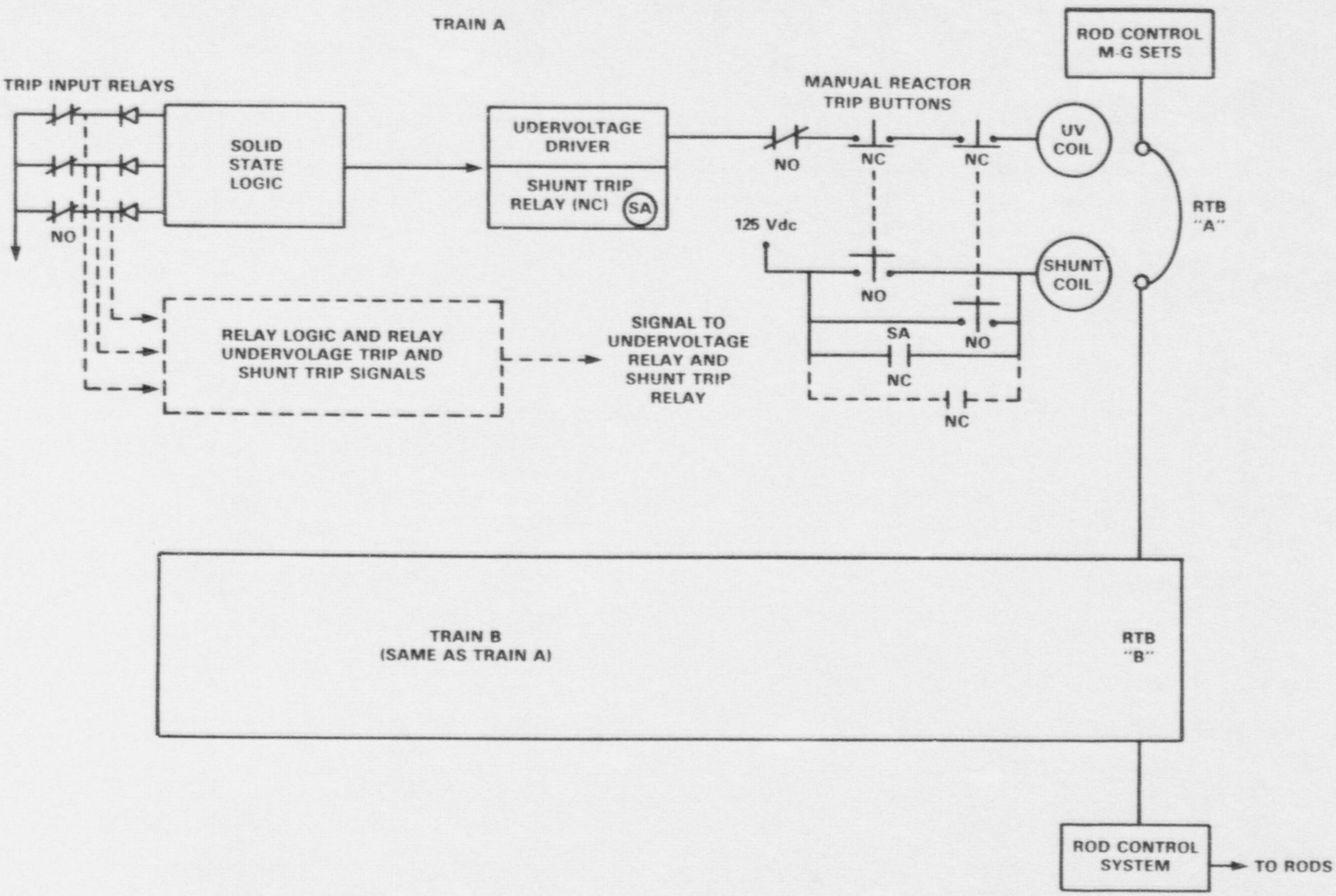


OPTION 3-DIVERSE RTB ACTUATION MECHANISM



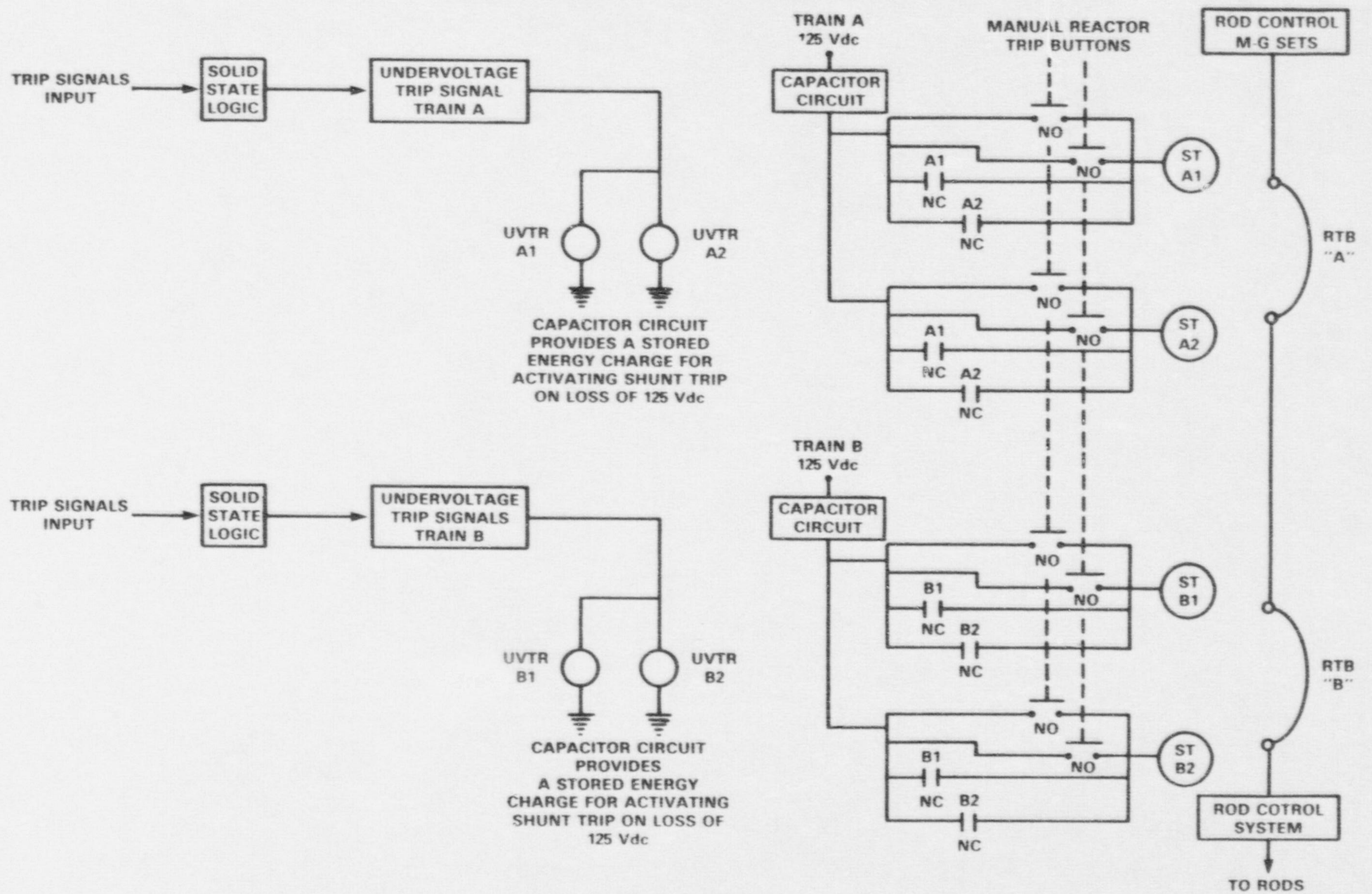
THE UNDERVOLTAGE TRIP SIGNAL WOULD OPERATE A SHUNT CONTACTOR SWITCH (AFTER 1 SEC. DELAY) THE CLOSING OF THE SWITCH WOULD CREATE A CURRENT PATH THROUGH A RESISTOR TO GROUND. EXCESS CURRENT WOULD FLOW THROUGH THE PATH AND CAUSE THE FUSE TO BLOW OR THE RTB TO OPEN, WHICH WOULD INSERT THE RODS AND TRIP THE REACTOR

OPTION 4-DIVERSE SSPS LOGIC AND UV TRIP FUNCTION



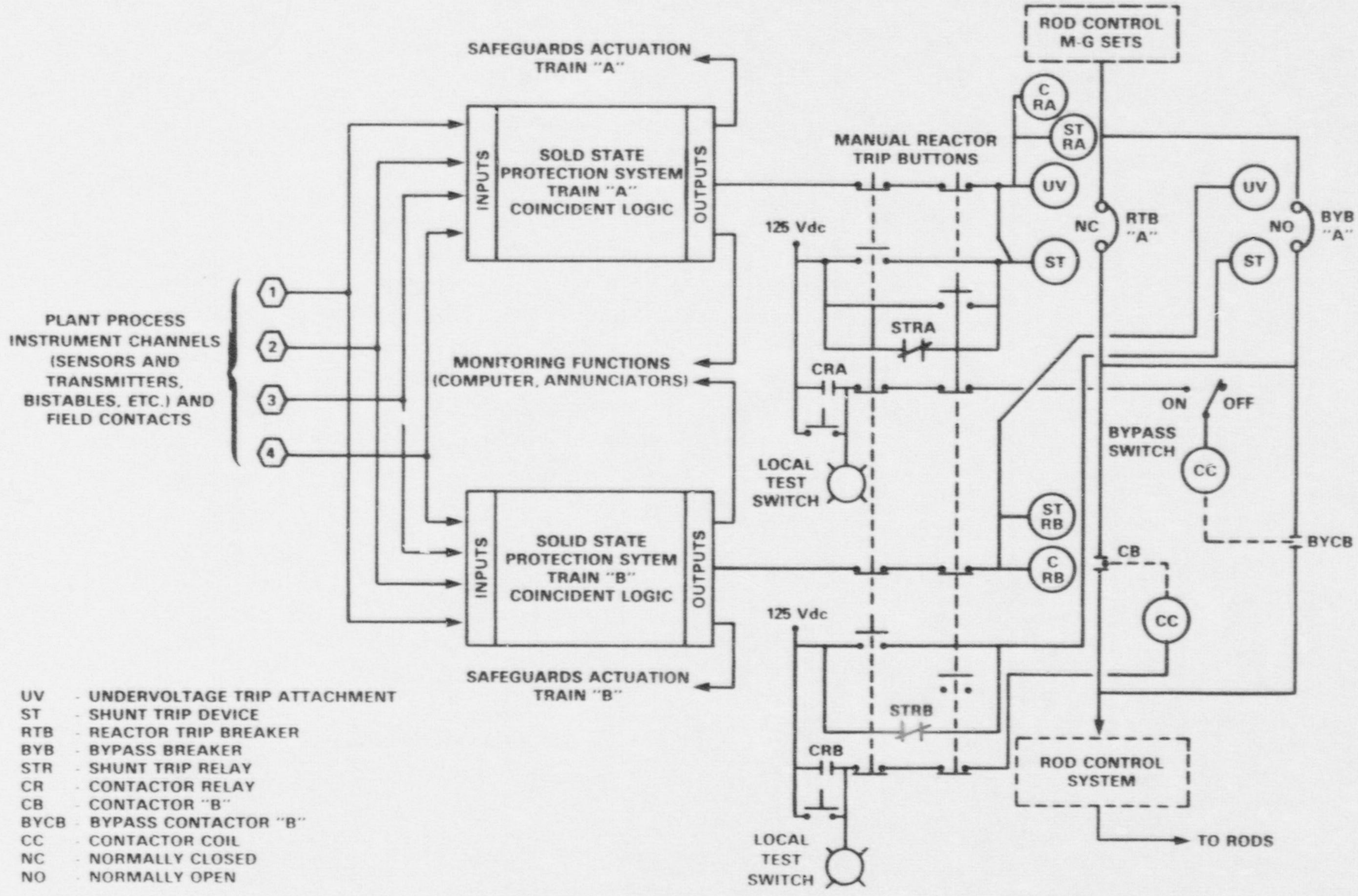
P-4

OPTION 5-DUAL SHUNT TRIP ACTUATION FOR EACH RTB



C-5

OPTION 6-REPLACEMENT OF ONE RTB WITH A CONTACTOR



UV - UNDERVOLTAGE TRIP ATTACHMENT
ST - SHUNT TRIP DEVICE
RTB - REACTOR TRIP BREAKER
BYB - BYPASS BREAKER
STR - SHUNT TRIP RELAY
CR - CONTACTOR RELAY
CB - CONTACTOR "B"
BYCB - BYPASS CONTACTOR "B"
CC - CONTACTOR COIL
NC - NORMALLY CLOSED
NO - NORMALLY OPEN